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Asphalt Roofing Manufacturers Association

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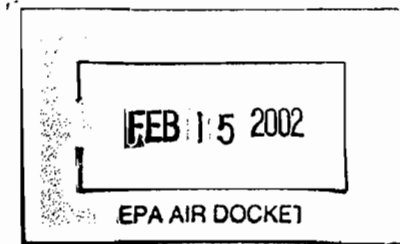
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February 14, 2002

BY HAND

Air and Radiation Docket and Information Center (6102)
Attention: Docket No. A-95-32
U.S. Environmental Protection Agency
Room M-1500, Waterside Mall
401 M Street, SW
Washington, DC 20460



Re: Proposed National Emission Standards for Hazardous Air Pollutants: Asphalt Processing and Asphalt Roofing Manufacturing; Proposed Rule
66 Fed. Reg. 58610 (Nov. 21, 2001), Air and Radiation Docket No. A-95-32

Dear Sir or Madam:

On behalf of the members of the Asphalt Roofing Manufacturers Association (ARMA), I am pleased to submit the enclosed comments on the above-referenced proposed rule. ARMA appreciates the extra time it was given to develop comments, and we submit these comments before the February 21, 2002 deadline that ARMA was given. See the enclosed January 18 and January 22, 2002 e-mail correspondence between myself and Rick Colyer of U.S. EPA's Office of Air Quality Planning and Standards. Likewise, several ARMA members also may submit individual comments by this deadline, in order to facilitate coordination among members of ARMA and eliminate duplicative comments.

ARMA is the North American trade association that represents the majority of the asphalt roofing industries manufacturing companies and their raw material suppliers. Together these companies produce a variety of asphalt-based residential and commercial roofing systems, including asphalt shingles, roll roofing, built-up roofing systems, and modified bitumen-roofing systems. Some members also process asphalt that is used in the manufacture of such shingles, roofing, and roofing systems.

We appreciate the opportunity to file these comments on a proposed rule that will have a significant impact on our members. If you have any questions, please feel free to call me at (202) 207-1112.

Sincerely,

Russell K. Snyder
Executive Vice President

Asphalt Roofing Manufacturers Association

cc: Rick Colyer, EPA/OAQPS (w/enclosures)

From: Colyer.Rick@epamail.epa.gov [SMTP:Colyer.Rick@epamail.epa.gov]
Sent: Tuesday, January 22, 2002 7:18 AM
To: Snyder, Russ
Cc: 'Crowder.Jim@epamail.epa.gov'; 'Shaver.Sally@epamail.epa.gov'
Subject: Re: Request for Extension

Russ,

I do not have authority to grant a formal extension. However, I and my management here will accept, consider, and respond formally to your comments in a background information document and the preamble to the final rule. We have always done so here with no exceptions to my knowledge, as long as the comments were relevant and not frivolous (and also not too late). As I stated earlier, it would take us longer to prepare and publish a FR notice than to receive your comments.

Thanks
Rick

"Snyder, Russ"
<rsnyder@kellenco
mpany.com> To: Rick Colyer/RTP/USEPA/US@EPA
cc: Jim Crowder/RTP/USEPA/US@EPA, Sally
Shaver/RTP/USEPA/US@EPA
01/18/02 04:16 PM Subject: Request for Extension

Rick:

Per our conversation earlier this week, you indicated that EPA would accept and fully consider ARMA comments on the Proposed MACT Standards for Asphalt Processing and Asphalt Roofing Manufacturing, 66 Fed. Reg. 58610 (Nov. 21, 2001) Air Docket No. A-95-32 after the comment deadline of January 22, 2002. As we discussed, it is anticipated that ARMA will need an additional 30 days to complete our comments to this important MACT Standard. We appreciate your willingness to accept this request. ARMA would ask that you verify receipt of this e-mail and acceptance of our request for an extension by sending a return e-mail at your earliest convenience.

Regards,

Russell K. Snyder
Executive Vice President
Asphalt Roofing Manufacturers Association

Comments of the Asphalt Roofing Manufacturers Association

**National Emission Standards for Hazardous Air Pollutants: Asphalt
Processing and Asphalt Roofing Manufacturing; Proposed Rule
66 Fed. Reg. 58610 (November 21, 2001)**

Air Docket No. A-95-32

February 15, 2002

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Comments of the Asphalt Roofing Manufacturers Association

National Emission Standards for Hazardous Air Pollutants: Asphalt Processing and Asphalt Roofing Manufacturing; Proposed Rule 66 Fed. Reg. 58610 (November 21, 2001)

The Asphalt Roofing Manufacturers Association (ARMA) appreciates the opportunity to comment on the above-referenced proposed rules, which will have a significant impact on ARMA's members. ARMA is the North American trade association that represents the majority of the asphalt roofing industry's manufacturing companies and their raw material suppliers. Together these companies produce a variety of asphalt-based residential and commercial roofing systems, including asphalt shingles, roll roofing, built-up roofing systems, and modified bitumen roofing systems. Some members also process asphalt that is used in the manufacture of such shingles, roofing, and roofing systems.

ARMA members that process asphalt and manufacture asphalt roofing products are subject to a variety of air quality control requirements, including state implementation plan (SIP) rules, state air toxics program provisions, and the new source performance standards (NSPS) for asphalt processing and asphalt roofing manufacturing. These NSPS are codified at 40 CFR part 60, subpart UU (§§ 60.470 through 60.474).

We appreciate EPA's efforts in working openly with ARMA and its member companies in the development of these proposed asphalt processing and asphalt roofing manufacturing maximum achievable control technology (MACT) standards.¹ This development process has taken a number of years, and has involved such time-consuming and expensive tasks as emissions testing and surveying of facility operations. We are confident that the open process helped EPA to better understand the asphalt processing and asphalt roofing manufacturing industries. This better understanding, in turn, undoubtedly improved the quality of the proposal.

ARMA believes that many aspects of the proposal are soundly reasoned and consistent with EPA's statutory mandates. Although the proposed MACT standards will impose significant costs for the industry, we are interested in working to achieve the Clean Air Act's (CAA's) goal of reduced hazardous air pollutant (HAP) emissions from manufacturing operations. Other provisions of the proposal are of concern, however, and we urge EPA to modify them when the agency issues the final rule. We have tried to be as specific as possible in these comments about the identified problems and our suggested solutions, but would be happy to provide further clarification to EPA staff. Please let us know if you have any questions or desire additional information. We would be happy to meet with you to help clarify any points.

¹ These standards, which will be codified in 40 CFR part 63, subpart LLLLL, will be referred to as the "asphalt roofing MACT standards" or simply the "MACT standards" in these comments.

We begin these comments with a summary of our major points. The sections following the summary provide more detail.

I. Summary

ARMA agrees that it is appropriate to use particulate matter (PM) and total hydrocarbons (THC) as surrogates for the organic HAP to be regulated by the MACT standards. We disagree, however, with statements in the proposal about particular HAP. For example, there is no reliable data suggesting that hexane is emitted by asphalt processing or roofing manufacturing facilities. EPA should also clarify in the preamble to the final rule that it previously overestimated polycyclic organic matter (POM) emissions from the industry. In addition, it should correct the proposal's erroneous references to "roofing tar emissions." EPA also needs to rectify its incorrect statements that the speciated test data from the joint EPA-ARMA testing program are not valid.

For the most part, ARMA agrees with the way EPA has defined "affected source" for both asphalt processing facilities and asphalt roofing manufacturing facilities. Furthermore, we support the way the proposal would make compliance with the MACT standards essentially replace compliance with the subpart UU NSPS for certain units. We also support EPA's proposed rules for allocating shared storage tanks and adhesive applicators. But we oppose making low-emitting storage tanks and loading racks subject to the rule. ARMA proposes an asphalt vapor pressure threshold for these types of sources that would remove *de minimis* sources from the rule's scope. This true vapor pressure applicability threshold would be in addition to the proposal's mass applicability threshold for storage tanks. We also recommend other changes to definitions used in the proposal, and suggest clarifications regarding how a facility can determine whether it is a "major source" under CAA §112.

ARMA supports EPA's decision to use operating limits in the MACT standards. We also support the agency's decision not to set a MACT floor or standard for hydrogen chloride (HCl). ARMA does not believe, however, that EPA has interpreted the MACT "floor" provisions of CAA §112(d)(3) correctly. These incorrect interpretations have resulted in overly stringent MACT floor levels (and thus standards). While EPA properly concluded that increasing the temperature of a thermal oxidizer above 1200°F does not result in better HAP destruction, we disagree with EPA's derivation of the floor levels for combustion efficiency and THC destruction efficiency. EPA's calculation of these floors did not properly account for variability and also reflected statistical errors. ARMA believes that the costs of control do not justify the establishment of any "beyond-the-floor" MACT standards. In fact, we believe that control costs are higher than EPA estimated.

We agree with the three-year compliance date for existing sources. ARMA also supports the inclusion of provisions to ensue that a facility will not be in violation of the MACT standards during a startup, shutdown, or malfunction (SSM) event, as long as the owner/operator follows its SSM plan during such occasions. But EPA should adopt a compliance approach similar to that found in its compliance assurance monitoring (CAM) rule, so a facility that registers a deviation is given the opportunity to quickly

implement a Quality Improvement Plan (QIP) before a finding of violation. We also think that EPA should create options for emissions averaging.

EPA should clarify the rules to better indicate that facilities may conduct their MACT performance testing with a product that is expected (based on a knowledge of the manufacturing process) to result in the highest asphalt emissions per ton of asphalt processed. EPA should also amend the rules to allow performance testing to be conducted by the later of (1) the first August 15 following the compliance date for existing sources, or (2) 180 days following the compliance date for existing sources. ARMA favors including rule provisions that allow facilities to use qualified data from previous testing in lieu of conducting all or part of a performance test.

We agree with the proposal's position that requiring the use of continuous emissions monitoring systems (CEMS) or continuous opacity monitoring systems (COMS) is unreasonable and unnecessary, although we favor giving facilities the option to use such systems. Facilities also should have the option of using a chart recorder, provided that the owner/operator is willing to accept that exceedance of the numerical value of the operating limit for any 15-minute data point will be treated as a "deviation" under the rules. EPA should modify the rules so that a facility using an electrostatic precipitator (ESP) as a PM control device can select which parameters are appropriate for demonstrating compliance. In measuring differential pressure at another type of PM control device to demonstrate compliance with a PM operating limit, facilities should be allowed to either (a) develop a differential pressure monitoring parameter during a performance test (as the proposed rules require), or (b) simply follow manufacturer specifications for the control device.

Finally, ARMA believes that much of the proposal's discussion of health effects resulting from exposure to HAP is misleading. Some of the described effects might result from exposure to high concentrations of the cited HAP. But the proposal fails to state that exposure to the relatively low HAP emissions from an asphalt processing or asphalt roofing manufacturing facility will result in much lower exposures. EPA should make this point clear in the preamble to the final rule.

II. Pollutants Regulated and Validity of Test Data

Use of PM and THC As Surrogates for Organic HAP

ARMA supports the use of particulate matter (PM) and total hydrocarbons (THC) as surrogates for the organic HAP that will be regulated under the MACT standards. As EPA points out (on p. 58612, col. 2), the HAP volatilized from asphalt can be present in both condensed PM and gaseous forms. Regulating PM or THC emissions, as appropriate, will control HAP emitted during asphalt processing and asphalt roofing manufacturing processes.

In addition, it would not be practical (or even possible in some cases) to regulate HAP emissions directly. Monitors and monitoring methods do not exist for many HAP. In other cases, speciation of HAP would be prohibitively expensive. By using the PM

and THC surrogates, operating parameter limits instead can be used to measure compliance. These parameter limits will ensure the same degree of HAP control as could be achieved if more direct HAP measurement methods were used.

Preamble Statements About Particular HAP

In the proposal, EPA states that approximately 98 percent of the HAP emissions from asphalt processing and asphalt roofing manufacturing are from formaldehyde, hexane, hydrogen chloride (HCl), phenol, polycyclic organic matter (POM), and toluene (p. 58612, cols. 1-2). In addition, a background memorandum in the docket lists estimated baseline hexane emissions as 3.9 tons per year (tpy). See September 11, 2001 memorandum from Mary Lalley of ERG to Rick Colyer of EPA/OAQPS, on "Cost and Emission Reduction Estimates Associated With the Asphalt Processing and Asphalt Roofing Manufacturing NESHAP," Docket No. II-B-17 (Sept. 11 ERG Cost and Emissions Memo), at p. 3, Table 1. ARMA disagrees that there are any reliable data suggesting that hexane is emitted from asphalt processing and asphalt roofing manufacturing.

EPA's belief that hexane is emitted from industry processes apparently is based upon Fourier transform infrared (FTIR) spectrometry data from emissions testing conducted at the CertainTeed plant in Shakopee, Minnesota. As ARMA has previously pointed out to EPA, however, the spreadsheets recording the results from these FTIR tests were inaccurate in their reporting of hexane emissions. During the tests for THC and other substances, the compounds in the hexane through isooctane chain lengths were not actually measured due to interferences. The THC data, which should have been recorded as "THC measured as hexane," was incorrectly recorded in the spreadsheet simply as hexane. It was incorrect to record the THC emissions in this way. See March 18, 2001 letter from R. Snyder of ARMA to R. Colyer of EPA/OAQPS, responding to EPA's questions raised during and after the February 27, 2001 meeting with ARMA and EPA, Docket No. II-D-29, at p. 10. The final rule therefore should clarify that there are no reliable data suggesting that hexane is emitted from either asphalt processing or asphalt roofing manufacturing operations. The erroneous emissions estimates in the Sept. 11 ERG Cost and Emissions Memo and any other documents should also be corrected.

Although ARMA does not dispute that minute amounts of POM are emitted from asphalt processing operations, it is important for EPA to recognize that earlier EPA estimates of POM emissions from asphalt processing and asphalt roofing manufacturing were many times greater than the actual emissions of these substances. In a 1997 emissions inventory of "section 112(c)(6) pollutants," EPA provided estimates of polynuclear aromatic hydrocarbon (PAH) emissions from various industries.² These PAH emissions were used as a surrogate for POM emissions. As ARMA pointed out to EPA staff in September 1998, these PAH emissions estimates were much too high for several reasons. Among other things, EPA used an emissions factor for asphalt

² See "1990 Emission Inventory of Section 112(c)(6) Pollutants" Final Report, June 1997, distributed by the Emission Factor and Inventory Group (MD-14), Emissions, Monitoring and Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina; 62 Fed. Reg. 33625 (1997) (notice of inventory).

processing that was several orders of magnitude too high. The EPA estimates were also based on erroneous data concerning asphalt roofing industry shingle production and the asphalt content in roofing materials. As ARMA previously explained to EPA, we believe that these errors made EPA's estimates many times too high. In fact, ARMA's calculations showed that industry PAH emissions were less than 3 percent of the estimate in the 1997 EPA §112(c)(6) emissions inventory.³

EPA apparently has recognized these various errors because Table 1 of the Sept. 11 ERG Cost and Emissions Memo lists estimated baseline emissions for POM as 0.85 tpy. See p. 3. This figure is in the range of ARMA's emissions estimate. Because erroneous data in the public domain can result in real problems for ARMA members, we ask EPA to clarify in the preamble to the final asphalt roofing MACT standards that the PAH emission estimates for the industry found in the 1997 section 112(c)(6) pollutant inventory were much too high. We are particularly concerned that these corrections be made because the amount of POM emissions from an industry can have regulatory implications under §112(c)(6) and §112(k). Given the minute amount of POM emissions from the industry, the preamble to the final rule should not include POM as one of the HAP that make up 98 percent of the total HAP emissions from the regulated source categories. In addition, the proposal's discussion on the health effects of POM should be omitted from the preamble to the final rule.

EPA also needs to correct the proposal's erroneous reference to "roofing tar emissions" (p. 58613, col. 1, in the POM section). While there is a substance known as "coal tar" – which is not derived from petroleum and is neither used nor emitted by either asphalt processing or asphalt roofing manufacturing operations – there is no such substance known as "roofing tar". The correct terminology for industry emissions is "asphalt emissions", not "roofing tar emissions." The preamble to the final rules and all supporting documentation should reflect this correction, and the final rule preamble should acknowledge that the proposal's reference to "roofing tar emissions" was mistaken.

Validity of Test Data

We strongly disagree with the proposal's statement that "[u]nfortunately, the majority of the speciated HAP data collected from the [joint EPA-ARMA] test program were not valid due to calibration errors during testing" (p. 58622, col. 1). The preamble offers no support for this statement, and we disagree with the assertions made in a docketed memorandum from EPA's contractor. See July 27, 2001 memorandum from Danny Greene of ERG to Rick Colyer of EPA/OAQPS, entitled "Summary of the Asphalt Processing and Asphalt Roofing Manufacturing NESHAP Test Program" (Docket No. II-B-18) (hereinafter "July 27, 2001 Greene memo").

³ See "Polyaromatic Hydrocarbon Emissions From Asphalt Processing and Roofing Operations," September 1998, submitted to Juan Santiago of EPA's Office of Air Quality Planning and Standards on September 17, 1998. Copies of the report and the accompanying September 17, 1998 cover letter are attached to these comments as Attachment 1.

ARMA is confident that nearly all the speciated data are valid. The testing was done with EPA contractors, using EPA test methods. Moreover, the sampling plans and test methods were reviewed together with ERG – and then reviewed by, discussed with, and approved by EPA. EPA staff also participated in the sampling process. In addition, the wet chemistry data and most of the FTIR data were within quality assurance/quality control (QA/QC) limits.

The only questionable test data are FTIR spectrometry data from emissions testing conducted in 1995 at the CertainTeed plant in Shakopee, Minnesota. This was the first time that FTIR had been used on an asphalt source. As noted in the report subsequently issued on this sampling, “The analysis of the field sample revealed the need for further test method development between the wet chemistry procedures and the FTIR method.”⁴

As ARMA has explained to EPA, since the 1995 sampling there have been significant advances in the FTIR method, the availability of reference standards, and sample conditioning techniques. The FTIR method was used with repeatable results on asphalt roofing sources during sampling conducted by ARMA in 1998 and 1999. These results on similar sources (coaters at Minneapolis, Fremont and Frederick) were consistent with each other, but significantly different from the results collected from Shakopee in 1995. See Docket No. II-D-29, at p. 10.

We do not understand why EPA does not appear to have incorporated the 1998-1999 data from the joint test program into its analyses. While in the end this omission does not affect the MACT floor levels or standards because EPA is using THC and PM as surrogates for HAP, it is puzzling that EPA relied only upon the 1995 test data.

ARMA has already corrected the incorrect assertions made in the July 27, 2001 Greene memo. The memo largely repeats the arguments made in two internal ERG memoranda dated November 10 and 11, 1999. ARMA’s contractor, Enthalpy Analytical, rebutted arguments in these two 1999 memoranda concerning “double modulation” in the FTIR results, a supposed (and unspecified) “instrument electronics problem,” and other issues. Rather than repeat these rebuttals here, we attach (as Attachments 2 and 3) copies of a May 4, 2000 letter from Steven Eckard and Peter Zemek of Enthalpy Analytical to Juan Santiago of EPA/OAQPS, and an April 11, 2000 letter from Gerald Auth and Brian Wright of MIDAC Corporation to Peter Zemek and Todd Grosshandler of Enthalpy Analytical. These two attachments describe why the test results are reliable.

Simply put, with the exception of the test results from the early FTIR testing at the CertainTeed plant in Shakopee, Minnesota, the test results from the joint EPA-ARMA testing program are valid. Accordingly, in the preamble to the final rule EPA should correct the mistaken assertions on test data validity found in the proposal.

⁴ The following problems were noted in the analysis of the 1995 data: (a) The FTIR had difficulty in handling the wide range of similar hydrocarbons and the resultant interferences that occurred; (b) The compounds in the hexane through isooctane chain lengths were not actually measured due to interferences; and (c) There was strong interference between the formaldehyde peak and the aliphatic hydrocarbons, which make up a major part of the gas phase emissions. See Docket No. II-D-29, at p. 10.

III. Applicability

ARMA does not object to many of the applicability provisions of the rule. For example, for the most part we agree with the way EPA has defined “affected source” for both asphalt processing facilities and asphalt roofing manufacturing facilities. We also support the provision that would make compliance with the MACT standards supplant compliance with the subpart UU NSPS for certain units. We disagree, however, with making low-emitting tanks and loading racks subject to the rule. Below we propose an asphalt vapor pressure threshold for these types of sources. Such a threshold would exclude *de minimis* emissions sources from the scope of the rules. This vapor pressure applicability threshold, which comes directly from NSPS for storage tanks, would supplement the overly restrictive mass applicability threshold for tanks that EPA has included in its proposed MACT rules. We also comment on several other aspects of the proposal’s applicability sections and related definitions.

Storage Tanks and Loading Racks

As we have previously informed EPA staff, we believe it inappropriate to regulate storage tanks with low volatile emissions at asphalt processing and asphalt roofing manufacturing facilities. The same is true for loading racks. EPA certainly has discretion not to regulate units and processes with *de minimis* or low HAP emissions; the agency regularly uses its discretion in this way in MACT rulemakings. (For example, EPA has not required controls for *all* emission sources of HAP at organic chemical plants, petroleum refineries, and many other types of industry sources regulated under EPA’s MACT standards.) Deciding not to establish standards for low-emitting units is particularly appropriate when, as is the case here, control costs are high. See Appendix B of these comments regarding high control costs for asphalt storage tanks and loading racks with low true vapor pressures. Yet, at asphalt processing facilities the proposed rule would regulate all asphalt storage tanks with a capacity greater than 1.93 megagrams (2.13 tons). See Table 1 to Subpart LLLLL, no. 1, and preamble at p. 58620, col. 1⁵. It would also regulate *all* loading racks, regardless of capacity. See Table 1 to Subpart LLLLL, no. 1.

We suggest a better approach for determining applicability for asphalt storage tanks and loading racks. In addition to the 1.93 megagrams capacity threshold for tanks included in the proposal, EPA should also include a vapor pressure threshold for storage tanks and loading racks. This proposal is taken directly from EPA’s NSPS for storage tanks. 40 CFR part 60, subparts Ka. In subpart Ka, petroleum liquids storage tanks are required to install a floating or fixed roof (techniques for controlling volatile organic emissions) only if the stored liquid has a true vapor pressure equal to or greater than 10.3 kilopascals or “kPa” (1.5 psia). 40 CFR §60.112a(a). We suggest using this same true vapor threshold cutoff in the asphalt roofing MACT standards; the tanks would be subject

⁵ EPA appears to have chosen the 1.93 megagram threshold because no sources are using a thermal oxidizer to control emissions from storage tanks with a capacity lower than this figure. See p. 58620, col. 1. As explained in the text, however, there is no legal or policy requirement to mandate MACT controls on particular emission units simply because some similar units of that size are regulated. Instead, EPA is to use its judgment in determining which units are worthwhile to control.

to the standards only if the stored liquid has a true vapor pressure greater than or equal to 10.3 kPa (1.5 psia). This threshold would also be almost identical to the 10.4 kPa threshold that EPA established for existing storage vessels subject to the petroleum refinery MACT standards codified at 40 CFR part 63, subpart CC. See proposal at p. 58624, col. 2.

If the vapor pressure does not reach this 10.3 kPa threshold value, there should be little concern about volatile HAP emissions. In fact, only five years ago an EPA Regional Office noted that the heavy nature of asphalt made emissions from storage tanks unlikely. In response to an inquiry from the Mississippi Department of Environmental Quality concerning the applicability of the subpart Kb NSPS to asphalt storage tanks, the Region explained that the tanks probably would not be subject to the rules because volatile emissions would be low. The applicability letter states: "Because asphalt is composed of heavy organic compounds, it may not emit VOCs to the atmosphere even if it is stored at an elevated temperature....Because the vapor pressure of asphalt is very low, an owner or operator of an asphalt storage tanks would probably be subject only to recordkeeping requirements...." Aug. 7, 1996 letter from Jewell A. Harper of EPA Region 4 to Dwight R. Wylie of the Mississippi Department of Environmental Quality, Control No. 9700029 in the Applicability Determination Index found on EPA's Web page. This letter is included as Attachment 4 to these comments. Moreover, the asphalt roofing MACT proposal itself points out that "[b]ased on limited vapor pressure data and average operating temperatures for asphalt tanks, it is unlikely that the vapor pressure of asphalt would trigger the petroleum refinery NESHAP control requirements" (p. 58624, col. 2).

The same basic principles regarding applicability thresholds that apply to storage tanks also apply to loading racks. If the vapor pressure on these loading racks at asphalt processing and asphalt roofing manufacturing facilities is relatively low, the volatile emissions will also be low. It would not be cost-effective to route these low emissions to a thermal oxidizer, particularly because it may require extensive and costly ductwork to send the low-concentration gases to the control device. See Appendix B. Furthermore, if a facility applied controls to loading racks with low vapor pressure, it might actually increase volatile emissions because the increased airflow associated with the controls could lead to greater volatilization. For these reasons, EPA should modify its asphalt roofing MACT standards so that only loading racks with a true vapor pressure of greater than or equal to 10.3 kPa (1.5 psia) are subject to control requirements in the MACT standards.

Definition of "Affected Sources"

ARMA agrees with EPA that the "affected sources" under the standards should be defined as the asphalt processing facility and the asphalt roofing manufacturing line, rather than the individual pieces of equipment found at the facility and the line. See p. 58617, cols. 1-2. We agree that minor changes to a processing facility or a manufacturing line should not trigger "new source" MACT limits for the replaced equipment. That would make no sense and would serve as a disincentive to make necessary or appropriate changes to outdated equipment. It might also dissuade facilities

from undertaking admirable pollution prevention efforts if a reconfiguration or replacement of process equipment were needed to utilize lower-emitting raw materials or fuels.

Definitions of Facilities and Units Subject to the Standards

Overall, ARMA believes that EPA did a commendable job in defining the affected facilities and emission units. EPA took the time to study and understand our industry; accordingly ARMA has relatively few corrections to the definitions. We trust that the information ARMA provided to EPA in the years leading to the MACT proposal helped further this understanding.

As might be expected, however, we do have several corrections to defined terms in the proposed rules. Perhaps our most important correction concerns the proposal's inclusion of the asphalt roofing manufacturing "coater" within the definition of "saturator." We realize that the proposed definition of "saturator" follows the definition of the term in the subpart UU NSPS. 40 CFR §60.471. It is more accurate to differentiate between the saturator and coater, though, because they are truly separate units with different characteristics. The best way to accomplish this is by creating a separate definition of "coater" in §63.8698. The reference to "coater" in the definition of "saturator" therefore would be struck, so that the last sentence of the definition would now read: "The term saturator includes the saturator and wet looper." Similarly, in the definition of "asphalt roofing manufacturing line", the word "coater" should be moved outside of the parentheses following "saturator". The second sentence of the corrected definition therefore would read: "An asphalt roofing manufacturing line can include the following equipment: a saturator (including wet looper), a coater, a coating mixer, a sealant applicator, and adhesive applicator, and associated storage and process tanks."⁶ Conforming change also would need to be made in items 2, 3, and 4 of Table 1 to Subpart LLLLL, in item 2 and 4-7 of Table 4 to Subpart LLLLL, and in any other places where the rules refer to saturator as including the coater.

Section 63.8698 would define a "coater" as "a piece of equipment to apply amended (filled or modified) asphalt coating to the top and bottom of the base substrate used in the manufacture of shingles and rolled roofing products."

The definition of "asphalt roofing manufacturing line" should also be corrected to more accurately describe how the number of lines at a facility is to be determined. The correction is to the last sentence of the definition, which states: "For example, an asphalt roofing manufacturing facility with two saturators would be considered to have two separate manufacturing lines." Our correction would revise this sentence to add the following underscored words: "For example, an asphalt roofing manufacturing facility with two parallel saturators (or two parallel coaters) would be considered to have two separate roofing manufacturing lines."

In the final sentence of the definition of "asphalt processing facility", the term "asphalt heating" should be deleted. It is unclear exactly what the term refers to. If the

⁶ We suggest stating that the line "can include" the equipment – rather than that it "includes" the equipment – because the exact equipment utilized at an asphalt roofing manufacturing line varies from line to line.

intent is to regulate heating in the tanks, that is already accomplished by the inclusion in the definition of “associated storage and process tanks”. Moreover, any heating in preheaters associated with the storage tanks will also be regulated because they are part of a closed system (a closed loop) including the tanks. To eliminate redundancy and avoid any unnecessary confusion, EPA therefore should simply delete “asphalt heating,” from the final sentence.

In the definition of “modified asphalt” EPA should substitute the word “polymer” for “plastic”. Facilities use additives other than plastics to make modified asphalt. The use of different types of additives is likely to grow over time. Using the term “polymer” would be more accurate and less confusing because it would capture the variety of different additives that may be used to create modified asphalt. Thus, the corrected definition would read: “Modified asphalt means asphalt that has been mixed with polymer modifiers.”

In the definition of “adhesive applicator”, the term “single-ply” should be deleted. Adhesive applicators are used to apply adhesive to shingles other than single-ply shingles. Thus, the corrected definition should read: “Adhesive applicator means the equipment used to apply adhesive to roofing shingles for producing laminated or dimensional roofing shingles.”

Rules For Allocating Shared Storage Tanks and Adhesive Applicators

As discussed above, ARMA believes that EPA should create a new vapor pressure applicability threshold for storage tanks. That having been said, for any tanks that still would be subject to the MACT standards, ARMA supports EPA’s proposed rules for allocating shared storage tanks. See §63.8682(b)(2)(i) and (ii). We also support the proposed allocation rules for shared adhesive applicators. *Id.* at (iii). It is necessary to allocate shared units to one regulated facility (or line) or another, and we think EPA’s approaches are reasonable.

Compliance With Certain Subpart UU NSPS By Complying With MACT

We applaud EPA for including proposed §63.8681(b), which provides that blowing stills, storage tanks, and saturators that are subject to the subpart UU asphalt processing and roofing manufacturing NSPS need only comply with the asphalt roofing MACT standards after the MACT compliance date. As EPA points out in the preamble (at pp. 58624-25), for these units compliance with the MACT standards will constitute compliance with the NSPS because the MACT standards and associated notification, recordkeeping, and reporting requirements are more stringent. Thus, requiring compliance with the two sets of standards (and two sets of paperwork requirements) would produce no environmental benefits even though it would be very costly for ARMA members. For this reason, §63.8681(b) makes sense.

We have two technical (but important) corrections to the provision. First, as described above, the “coaters” at asphalt roofing manufacturing facilities should not be lumped together with saturators by stating that the saturator includes the coater in addition to the wet looper. Thus, because coaters should be defined and treated

separately from saturators, §63.8681(b) should be amended by striking the “and” before “saturators” and adding “,and coaters” immediately following “saturators”. As EPA points out at pp. 58624-25, compliance with the coater MACT standards will constitute compliance with the subpart UU standards for coaters.

Second, §63.8681(b) prevents any redundancy and duplication for *existing* sources. But because the provision only becomes effective three years after publication of the final asphalt roofing MACT rule – the compliance date for existing sources – new or reconstructed sources built prior to that date would need to comply with both the NSPS and the MACT standards until the provision becomes effective. For example, assume that a new asphalt roofing line is constructed and started up one year after publication of the final asphalt roofing MACT standards. It will need to comply with the MACT standards immediately upon startup. See §63.8683(a)(2). Thus, the saturators and coaters will be complying with the MACT standards for two years prior to the effective date of §63.8681(b), and during these two years the facility will also need to show compliance with the less stringent but different NSPS for coaters and saturators. The facility also would need to comply with two sets of notification, recordkeeping, and reporting requirements during these two years. This would make no sense. EPA therefore should amend §63.8681(b) to provide that, following startup, blowing stills, storage tanks, saturators, and coaters at a new or reconstructed affected facility need only comply with the asphalt roofing MACT standards.

Determining Whether A Facility Is A “Major Source”

A facility will be subject to the MACT standards only if it is a CAA §112 “major source” or is located at a major source. See §63.8681(a). Many sources in the asphalt processing and asphalt roofing manufacturing industries are “area sources” and thus will not need to comply with the MACT standards. Accordingly, it is important that there be a fairly streamlined way to demonstrate that a facility is an area source. We think the best way to make this demonstration is through emission factors that provide reasonable estimates of HAP emissions. ARMA has begun work on developing such HAP emission factors, and hopes to work closely with EPA in finalizing widely-accepted factors that can be used to show that a facility is an area source.

Of course, a facility also would be free to use emissions testing to estimate HAP emissions. But due to the high cost of such testing, companies should not be required to conduct such testing to show that their facilities have potential HAP emissions below the §112 major source thresholds.

Another important issue concerning whether a facility is a major source or an area source involves the use of chloride-based catalysts and resulting HCl emissions. As the proposal points out, some asphalt processing facilities need to use a chloride-based catalyst to produce a quality product, in large part because the quality of available asphalt flux often varies widely. Many other facilities do not use a chloride-based catalyst, though. Because the definition of “major source” is based upon potential HAP emissions, it is important to know whether to include potential HCl emissions in determining if a facility is a major source. Because a facility is allowed to use chloride-based catalysts only if its permit expressly states that it may do so, EPA should clarify

that potential HCl emissions are to be included in such determinations only if an asphalt processing facility's CAA operating permit states that the facility may use a chloride-based catalyst.

IV. MACT Floor Levels and Standards

We have a number of comments concerning the proposed MACT floors and standards for asphalt processing and asphalt roofing manufacturing. These comments involve the use of operating limits, the choice of pollutants for which floors have been set, the methodology for calculating the floors (including accounting for variability), and EPA's decisions on whether to set more stringent "beyond-the-floor" standards. These various issues are discussed below.

Use of Operating Limits

ARMA supports the use of operating limits in the MACT standards. Although it is appropriate to set the emission limits in terms of destruction efficiency for THC (or thermal oxidizer combustion efficiency) and amount of particulate matter emitted per ton of product, it would be extremely expensive and impractical to measure compliance with these limits directly. Developing operating limits through a performance test solves this problem. Although we disagree with some of the implementation provisions for measuring compliance with the operating limits (see sections V through VII below), we agree with the general concept of using the limits. We also support the proposal's flexibility in allowing a source to reduce THC and particulate matter emissions in different ways; *e.g.*, the facility need not use an incinerator to destroy THC emissions.

Decision Not To Set A Floor or Standard for HCl

We agree that it would be inappropriate and contrary to congressional intent to regulate HCl emissions under the asphalt roofing MACT standards. We therefore support EPA's decision not to set a floor or a beyond-the-floor standard for HCl emissions.

We have little to add to the proposal's excellent explanation of why it would not be feasible or appropriate to bar the use of chloride-based catalysts or certain asphalt feedstocks (p. 58619, cols. 1-2, p. 58620, col. 3). ARMA provided similar information to EPA in a June 1, 2001 letter from Russ Snyder to Rick Colyer of EPA/OAQPS, containing ARMA's response to questions regarding blowing operations. Docket No. II-D-31.

We also agree with EPA that the proposal not to regulate HCl emissions is consistent with the holding in *National Lime Ass'n. v. EPA*, 233 F.3d 625 (D.C. Cir. 2000). As EPA points out, in that case the court did not find that process substitution was unavailable. Here, in contrast, it is clear that attempting to bar the use of chloride-based catalysts or certain asphalt flux feedstocks often would prevent the manufacture of a usable product meeting industry specifications. That, in turn, could result in the shutdown of many facilities. As EPA correctly points out, Congress did not intend for MACT standards "to drive sources to the brink of shutdown." H. Rep. No. 490, 101st

Cong., 2nd Sess. 328 (1990). For all these reasons, we support EPA's proposal on its decision not to regulate HCl emissions.

EPA's Interpretation of the Existing Source Floor Provisions of §112(d)(3)

ARMA believes that EPA incorrectly calculated the existing source MACT floors for asphalt processing and asphalt roofing manufacturing facilities by considering only the performance of the lowest-emitting sources in the database. In this way, the MACT methodology employed in the proposal overrides the statutory language of CAA §112(d)(3), which requires that EPA consider the actual regulatory emission limitations of the surveyed facilities.

The words "average emission limitation achieved" in CAA §112(d)(3)(A) and (B) clearly state the intent of Congress regarding the information upon which floors for existing sources are to be based, and the proposal's method of establishing floors is inconsistent with that intent. The term "emission limitation" is defined by CAA §302(k), which applies to the entire Act, as "a requirement established by the state or the administrator . . ." The phrase "average emission limitation achieved" in §112(d)(3), to be consistent with this definition, must be read as "*average state or federal requirement limiting emissions of a pollutant achieved.*"

The context suggests that the use of the term "emission limitation" in §112(d)(3), rather than "emission level" or "emission control," was deliberate, and intended to invoke the statutory definition. The same paragraph provides that floor control for *new* sources "shall not be less stringent than the *emission control* that is achieved in practice by the *best controlled* similar source . . ." (emphasis added). The obvious intent was to base the MACT floor for *new* sources on the best actual degree of emission control achieved by any source in practice, whether or not such degree of emission control was mandated by a regulatory requirement. But for *existing* sources Congress did not instruct EPA to base the floor on average "emission control" achieved; the defined term "emission limitation" was used. This choice of words is inexplicable unless Congress intended for floors for existing sources to be based on regulatory requirements, not levels of emission control, and said what it meant. See *Brown v. Gardner*, 513 U.S. 115, 120 (1994) (court must accord significance to disparate wording of different statutory provisions).

Moreover, the available legislative history is consistent with a plain language understanding of the phrase "average emission limitation achieved." The phrase first appeared in an amendment in the nature of a substitute (for S. 1630, as reported from committee) that was adopted on the Senate floor. S. Amdt. No. 1293, at 243 (March 5, 1990), 5 *Legislative History of the 1990 Clean Air Act Amendments*, at 7580-81. This language contrasted sharply with corresponding language in the committee bill, which spoke instead of "emissions level(s)" and "the level of control achieved by existing sources . . ." S. 1630 [Report No. 101-228] at 330-31, in 5 *Legislative History* at 8080-81. Thus, the Senate, with the acquiescence of the House,⁷ replaced language calling for

⁷ The House committee bill based floors on "emissions controls." H.R. Rep. No. 101-490, pt. 1, at 83 (1990), 2 *Legislative History* at 3107. The House subsequently adopted the Senate-passed language. 2 *Legislative History* at 2897.

the floor for existing sources to be based on “emission levels” with language specifying a defined term meaning regulatory requirements, while retaining emissions levels (“emission control” in the enacted bill) as the basis for floors for new sources. EPA should attribute significance to Congress’s substitution of the defined term “emission limitation” for the earlier references to “emission levels” or “controls.” Thus, EPA should set the existing source MACT floors based upon the actual emission limitations to which the best performing facilities are subject.

Selection of Best Units Rather Than Best Overall Facilities

Even if one were to assume that the legal argument on the existing source floors (set forth immediately above) is incorrect, ARMA believes that EPA’s basic proposed approach to selecting “the existing source and new source floors is flawed. We believe EPA erred in its determinations of the “best performing 12 percent of the existing sources” and the “best controlled similar source” (§112(d)(3)) because the agency looked to *individual units, and not overall facilities*. For example, EPA separately ranked the best performing and best-controlled saturators, blowing stills, tanks, loading racks, etc, rather than the best overall asphalt processing facilities and asphalt roofing manufacturing facilities. This results in the creation of hypothetical facilities upon which the existing source and new source floor levels are based. It probably also results in overly stringent floor levels. We think that this approach contravenes §112.

It is clear from the statute and the legislative history that the “best performing” and “best controlled” sources in a source category are to be *real*, not theoretical or hypothetical sources. The very use of phrases such as “best controlled” in §112(d)(3) shows that Congress intended actual sources, operating under real life conditions, to be the benchmark for determining the MACT floors. As the Senate report on the 1990 Amendments made clear, Congress required “the selection of emissions limitations which have been *achieved in practice (rather than those which are merely theoretical)* by sources of a similar type or character. An emissions limitation achieved in practice is one based on control technology that works reasonably well (doesn’t require frequent and extensive modification or repair) under realistic conditions.” S. Rep. No. 228, 101st Cong., 1st Sess. (1989) (emphasis added).

The proposal states that EPA considered “determin[ing] the MACT floor across the affected source as a whole,” but that the agency opted to instead establish a floor for each type of process equipment because “the data are not sufficient to establish either a mass emission limit or a percent reduction for entire affected sources” (*id.*). Even if the data were not sufficient for these purposes, however, this would not excuse a failure to *select* the best sources by examining the facility as a whole. Floors for individual units then could be derived based on examination of the units found at these facilities.

Best Performing Thermal Oxidizers and Particulate Control Devices

Assuming *arguendo* that EPA’s basic methodological approach to setting the MACT floors is sound, we agree with EPA that thermal oxidizers operating above 1200°F do not appear to destroy organic HAP at a greater efficiency than thermal

oxidizers operating at 1200°F (p. 58618, col. 3). In fact, the results from the ARMA testing program show that there is no apparent relationship between thermal oxidizers operating above 1200°F and the destruction of organic HAP. See Docket No. II-D-30, January 15, 2001 report entitled “MACT Analysis for the Asphalt Roofing Manufacturing Category,” at pp. 16-17. Thus, in identifying the “floor technology” for controlling HAP present in THC, we believe it appropriate not to differentiate between thermal oxidizers operating at or above 1200°F.

ARMA also supports EPA’s conclusion that the appropriate “floor technology” for controlling HAP present in PM is a PM control device that can meet the subpart UU NSPS (p. 58618, col. 1). We agree that there are no data suggesting that better-performing PM control devices are in use in the industry.

Derivation of the Proposed Combustion Efficiency Floor

ARMA supports having the asphalt roofing MACT rules allow facilities to demonstrate compliance with the THC control requirements by either meeting a destruction efficiency standard or a combustion efficiency standard. We agree with EPA that the nature of the organic compounds in the exhaust gas and the high concentrations at the thermal oxidizer inlet can foul test equipment, thus making it difficult to measure destruction efficiency under some circumstances (p. 58622, col. 1).

As is explained in detail in Appendix A of these comments, however, we believe EPA’s derivation of the 99.6 percent combustion efficiency standard found in proposed Table 1 to Subpart LLLLL was incorrect, even assuming *arguendo* that EPA’s basic methodological approach to setting the standards was sound. The dataset is simply too small to support the proposal’s conclusion that thermal oxidizers operating at or above 1200°F can consistently achieve a combustion efficiency of 99.6 percent. Based on EPA’s own Fact Sheet on what thermal incinerators achieve in terms of combustion efficiency, we believe that the combustion efficiency standard should be set at 98 percent. See Appendix A, particularly sections 3.1, 3.2, and 4.0.

Setting the combustion efficiency standard more stringent than 98 percent will result in MACT standards that are not achievable because they do not account for variability. EPA and the courts have recognized the importance of accounting for such variability between facilities, processes, and test results. In *Sierra Club v. EPA*, 167 F.3d 658, 665 (D.C. Cir. 1999), the U.S. Court of Appeals for the D.C. Circuit stated in another MACT case (under CAA §129): “It is reasonable to suppose that if an emissions standard is as stringent as ‘the emissions control that is achieved in practice’ by a particular unit, then that particular unit will not violate the standard. This only results if ‘achieved in practice’ is interpreted to mean ‘achieved under the worst foreseeable circumstances.’” Similarly, under the technology-based NSPS, the D.C. Circuit’s decisions “evinced a concern that variables be accounted for, that the representativeness of test conditions by [sic] ascertained, that the validity of tests be assured and the statistical significance of results determined.” *National Lime Ass’n v. EPA*, 627 F.2d 416, 452-53 (D.C. Cir. 1980). See also *Portland Cement Ass’n v. Ruckelshaus*, 486 F.2d 375, 396 (D.C. Cir. 1973), *cert. denied*, 417 U.S. 921 (1974) (remanding NSPS in part due to “the lack of any indication of statistical reliability” in test results used to set standards).

When floors or standards are developed based on emissions test data, EPA needs to account for several types of variability to avoid forcing facilities to the brink of shutdown even where they have installed the best pollution control technology in use. The first type of variability concerns operational distinctions between facilities or units. Facilities and units within the same source category often are configured in different ways, and use different raw materials or fuels. These distinctions usually have a direct effect on resulting emissions, and on the performance that the various units are capable of achieving. The range of expected emissions values for similar facilities can be determined statistically *if* enough data are available. Natrella, *Experimental Statistics*, National Bureau of Standards Handbook 91, chapter 1 (revised ed., 1966).

In short, the performance of control technology at one plant may not be “representative” of such performance at other plants, due to different process configurations, different unit or facility size, different feedstocks used, and other factors. Because MACT floors and standards usually are expressed as numerical limits – instead of requiring installation of a particular type of technology – it therefore is necessary to account for these variations in some way.

Another type of variability that EPA generally accounts for – and that must be considered if technology-based standards are to be written so as to make them “achievable” by sources installing the best pollution controls – concerns operational distinctions present *between tests at the same facility or unit*. This is commonly referred to as “between-test variability.” Even where conditions appear to be the same when two or more tests are conducted, variations in emissions are often caused by differences in a variety of factors such as operation of the control equipment, operation of the process unit in general, temperature and humidity, atmospheric pressure, and moisture content of the waste. In addition, slightly different settings for emissions testing equipment and differences in sample handling lead to different test results.⁸ Varying results may also be caused by use of different field teams to conduct the testing, or different laboratories to analyze test results. All these variations are to be expected; they are typical, not aberrations. Moreover, it is not uncommon for the testers and analyzing laboratories to make errors when conducting emissions tests. See, e.g., Natrella, *Experimental Statistics*, *supra*, at p. 17-1 (“[e]very experimenter ... has obtained a set of observations, purportedly taken under the same conditions, in which one observation was widely different, or an outlier from the rest”).

An achievable standard needs to account for these differences between tests. As the D.C. Circuit has held under CAA §111, “a uniform standard must be capable of being met under most adverse conditions which can reasonably be expected to recur....” *National Lime Ass’n*, 627 F.2d at 431 n.46. See also *Portland Cement Ass’n*, 486 F.2d at

⁸ Sampling methods produce variable results due to “imprecision.” Imprecision is not caused by mistakes. Rather, it is the result of all the small variations in exactly how instruments respond and how individual test samples are collected, recovered and analyzed. For example, simultaneous particulate matter test results taken about 1½ inches apart have a standard deviation that is about 10 percent of a pair’s average. Hamil, H. F., and R. E. Thomas, *Collaborative study of particulate emissions measurements by EPA Methods 2, 3, and 5 using paired particulate sampling trains (Municipal Incinerators)*, EPA-600/4-76-014, March 1976, p.19.

396 (noting industry point that “a single test offered a weak basis” for inferring that plants could meet the standards). Without accounting for variation among different emissions tests, it cannot be determined with a significant degree of statistical confidence that even a single unit will not be able to meet the standard over a reasonable period of time, when one can expect adverse conditions to be present.

The courts have recognized this same basic principle in reviewing technology-based effluent standards under the Clean Water Act. As the Fifth Circuit stressed in reviewing “best practicable technology” or “BPT” standards under Clean Water Act § 304(b)(1):

The *same plant* using the *same treatment method* to remove the *same toxic* does not always achieve the same result. Tests conducted *one day* may show a different concentration of the *same toxic* than are shown by the *same test* on the *next day*. This variability may be due to the inherent inaccuracy of analytical testing, i.e., “analytical variability,” or to routine fluctuations in a plant’s treatment performance.

Chemical Manufacturers Ass’n v. EPA, 870 F.2d 177, 228 (5th Cir. 1989) (emphasis added). The Fifth Circuit upheld the standards because EPA expressly stated that they should be achievable “at all times apart from instances of upsets,” and because the Clean Water Act contains an “upset defense.” *Id.* at 230. See also *American Petroleum Institute v. EPA*, 540 F.2d 1023, 1035-36 (10th Cir. 1976) (“Even in the best treatment systems, changes occur in ability to treat wastes. ... [V]ariability factors present[] a practical effort to accommodate for variations in plant operations”); *FMC Corp. v. Train*, 539 F.2d 973, 985 (4th Cir. 1976) (variability factors account for “the fact that even in the best treatment systems changes continually occur in the treatability of wastes”). See also 47 Fed. Reg. 24534, 24546 (1982) (in setting general pH effluent limitation under the Clean Water Act, EPA pointed out that it “traditionally has recognized that it must take variability into account in establishing effluent limitations, and in recognition that 100 percent compliance is theoretically impossible, the Agency has generally set daily effluent limitations which would be met approximately 99 percent of the time”).

Yet a third type of variability is known as “within-test variability.” A single test at a facility usually includes at least three separate test “runs.” See 40 CFR § 63.7(e)(3) (for MACT standards under CAA §112); 40 CFR § 60.8(f) (for NSPS under CAA § 11). The same types of differences and errors that lead to “between-test variability” also cause variations in results between the various runs comprising a single test. See *Portland Cement Ass’n*, 486 F.2d at 397 (noting differences in conditions among several test runs).

As EPA itself pointed out in its brief in the *Sierra Club v. EPA* MACT case under CAA §129 (discussed above), simply trying to set a technology-based emission standard by considering a very limited dataset “ignores the critical distinction between an emission level that is ‘observed’ on a particular occasion versus an emission level the Administrator determines is ‘achieved in practice’ through performance because it is capable of being met continuously under the range of operating conditions that can reasonably be expected.” EPA brief at 35. Limited test results – the “observed” emissions levels – bear no relationship at all to what a variety of differently configured

plants (or even a single unit) can achieve on a continuous basis. This is because each test produces a very limited sample of data. It does not provide a full enumeration of the available data for the unit's performance over a long period of time. See Natrella, *Environmental Statistics*, *supra*, chapter 1.

In short, the very small dataset that EPA used to support its floor calculations in the asphalt roofing MACT proposal does not account for these various types of variability. Given this predicament, EPA should change course and set the combustion efficiency standard by considering the worst possible conditions that can be expected to be encountered by a thermal oxidizer operating at or above 1200°F. As is explained in Appendix A, we believe the appropriate standard is 98 percent combustion efficiency.

Derivation of the Proposed THC Destruction Efficiency Floor

We also disagree with EPA's derivation of the proposed 95 percent destruction efficiency floor for THC. See Table 1 to Subpart LLLLL, and preamble at p. 58622, cols. 2-3. We think this number is wrong for many of the reasons discussed immediately above. As is explained more fully in Appendix A of these comments, we believe the appropriate standard is 92 percent destruction efficiency. Setting the standard higher than this figure almost certainly will require replacement of a number of well-maintained control devices operating at or above 1200°F.

A review of the THC destruction efficiency data upon which EPA based its proposed standard shows that the lowest hourly THC destruction efficiency observed was 92.2 percent. See Appendix A, section 3.3 and Table A-1. In addition, in Appendix A ARMA has conducted a statistical analysis appropriate for the small dataset. This analysis supports a destruction efficiency standard of 92 percent. *Id.* at sections 3.3 and 3.3.1. Thus, in the final rule EPA should set the THC destruction efficiency standard at 92 percent.

Electric RTOs and Destruction Efficiency

Moreover, measuring the combustion efficiency standard in the manner set forth in the proposal could prevent the use of regenerative thermal oxidizers (RTOs) even though such incinerators generally are at least as effective as traditional thermal oxidizers in controlling THC. The only relevant source of carbon dioxide (CO₂) in an electric RTO comes from the destruction of hydrocarbons. ARMA therefore supports the Owens Corning suggestion (made in the company's comments on the asphalt roofing MACT proposal) that the CO₂ level be used to calculate carbon destruction efficiency. The sum of the carbon from the CO₂, THC and CO at the outlet of the control device could be used to calculate the input level of carbon. Under the Owens Corning formula, the standard destruction efficiency equation would then be used to calculate the destruction efficiency.

$$\begin{aligned}\text{Destruction efficiency} &= \{(\text{CO}_2 + \text{CO} + \text{THC}) - \text{THC}\} / \text{CO}_2 + \text{CO} + \text{THC} \\ &= (\text{CO}_2 + \text{CO}) / (\text{CO}_2 + \text{CO} + \text{THC})\end{aligned}$$

Carbon Destruction efficiency if a fossil fuel source is used is:

$$\{(\text{CO}_2 + \text{CO} + \text{THC}_{\text{outlet}} + \text{THC}_{\text{fuel}}) - \text{THC}_{\text{outlet}}\} / \text{CO}_2 + \text{CO} + \text{THC}_{\text{outlet}} + \text{THC}_{\text{fuel}}$$

$$(\text{CO}_2 + \text{CO} + \text{THC}_{\text{fuel}}) / (\text{CO}_2 + \text{CO} + \text{THC}_{\text{outlet}} + \text{THC}_{\text{fuel}})$$

The THC of natural gas or fuel oil would be obtained from a fuel analysis and fuel usage during the performance testing.

Consideration of “Beyond-the-Floor” Options

We disagree with EPA that it is appropriate to set a “beyond-the-floor” standard for wet loopers at new affected sources (pp. 58620-21). We do not believe that the costs associated with connecting a wet looper to a thermal oxidizer or similar control device justify the low amount of extra HAP emissions that will be controlled under such a beyond-the-floor standard. Even if EPA includes such a standard in the final rule, however, the rule should clarify that the beyond-the-floor standard does not apply to a coater that is not associated with a saturator. This result should clearly flow from a decision to remove the term “coater” from the definition of “saturator”, as we suggest in the Applicability section of these comments.

Moreover, it clearly is not cost-effective to set beyond-the floor standards for any other regulated units and processes at asphalt processing and asphalt roofing manufacturing facilities. We agree with EPA’s conclusions on this point (at pp. 58620-21), but think the case is even more clear than the proposal suggests. We believe that EPA significantly underestimated capital costs for thermal oxidizers. See Appendix C these comments. Thus, the proposal’s cost-effectiveness numbers (expressed in terms of removal cost per mass of pollutant) are too low.

V. Compliance Provisions

Although we support EPA’s choice of a three-year compliance period for existing sources, we disagree with the way “deviations” from operating limits are treated under the proposed rules. Furthermore, the MACT standards should provide an emissions averaging compliance option.

Compliance Date For Existing Sources

The proposed rules would require existing sources to comply with the MACT standards by the date three years following publication of the final rules. See §63.8683(b). We support this three-year compliance period because it will take many facilities that much time to carry out their compliance planning, purchase the necessary control and monitoring equipment, install the equipment and associated ductwork, and then fine-tune the equipment so that compliance can be achieved.

Treatment of Deviations From Operating Limits

As explained above in section IV, ARMA supports the concept of operating limits (also known as parameter limits). But the proposed rules would allow nearly all “deviations” from the limits (*i.e.*, all exceedances of limits except those that occur during periods of startup, shutdown, and malfunction) to be treated as violations of the standards. See §63.8691. We think this approach is excessively harsh, particularly

because several factors make it probable that established operating parameters will be exceeded at times even when a facility is operating its processes and control equipment well.

The proposal's compliance provisions are also inconsistent with the approach the agency established in its compliance assurance monitoring (CAM) rule and the subpart NNN fiberglass MACT standards. See 40 CFR part 64 (CAM rule), 40 CFR §63.1382(b) (wool fiberglass MACT compliance provisions), and 64 Fed. Reg. 31695, 31698-99 (wool fiberglass MACT final rule). Several ARMA members also manufacture fiberglass, and thus comply with the subpart NNN MACT standards. We consider EPA's inconsistent approaches in the two similar MACT standards to be evidence that EPA's actions in writing the asphalt roofing MACT compliance provisions are arbitrary, especially because the differences in the two rules are unexplained.

Under the CAM and wool fiberglass MACT rules, the facility is given a chance to quickly correct a deviation from its operating limits before a violation is registered. As the CAM rule recognized, this type of approach is particularly appropriate when compliance is measured through operating limits because emissions may be underneath the regulatory emission limit even though the operating limit established for the course has been exceeded. Moreover, this approach provides powerful incentives for a source to take "corrective action" swiftly by implementing its Quality Improvement Plan (QIP), so that normal operations (and emissions) can be restored. We therefore urge EPA to adopt similar compliance provisions in the LLLLL standards.

ARMA therefore suggests replacing the terms "continuous compliance" and compliance "at all times" throughout the rules and preamble with "compliance." For example, the term "continuous compliance" is used in §§ 63.8690 and 63.8691, and §63.8685(a) states that a facility must be in compliance with emission limitations and operating limits at all times except during periods of startup, shutdown, or malfunction. The term "deviation" should also be replaced with "excess emissions" in the rules. Although additional rule changes may be needed to make the compliance provisions consistent with the preferable CAM/QIP approach, these changes and the ones described immediately below should go most of the way towards fixing the proposed rules.

While §63.8685(a) should preserve the provision stating that compliance with MACT limits need not be demonstrated "during operations of startup, shutdown, and malfunction," the remainder of the subsection can be written as follows:

(a) On and after the compliance date stated in § 63.8683, the owner or operator shall operate all affected sources and associated control equipment according to the following requirements.

(1) The owner or operator must initiate corrective action within 1 hour when the monitored air pollution control equipment operating parameter level(s) is outside the operating limit(s) established during the performance test as specified in § 63.8687 (or through manufacturer specifications, to the extent allowed under these rules). The owner or

operator must also complete corrective actions in a timely manner according to the procedures in the facility's operations and maintenance plan.

(2) The owner or operator must implement a Quality Improvement Plan (QIP) consistent with the compliance assurance monitoring provisions of 40 CFR part 64, subpart D when the process parameter(s) is outside the limit(s) established during the performance test as specified in § 63.8687 (or through manufacturer specifications, to the extent allowed under these rules) for more than 10 percent of the total operating time in a 6-month block reporting period.

There is no need for a finding of violation when the facility quickly takes corrective action in this way. Findings of violation should be saved for situations in which a facility (1) does not correct the problem in a speedy manner, or (2) exceeds the operating limits for a significant percentage of the time during a 6-month block period.

Creating Option for Emissions Averaging

In many cases a facility will employ several control devices to comply with the asphalt roofing MACT standards. In these situations, we believe facilities should be given the option of demonstrating compliance by "averaging" the performance of the various control devices. Adopting this approach would somewhat ameliorate the inequities arising from EPA's flawed approach to defining the MACT floors based on the best performing individual process units rather than the best performing overall facilities. See section IV, discussion on "Selection of Best Units Rather Than Best Overall Facilities."

For example, if one thermal oxidizer operates at more than 1°F above its operating limit, another thermal oxidizer treating a gas stream with a comparable volume of emissions should be able to operate at 1°F below its operating limit without the facility being subject to a violation. Averaging in this way promotes economic efficiency because it allows the facility to achieve the most cost-efficient remissions reductions, while at the same time achieving at least the same degree of overall reductions that would be realized if the rules did not permit averaging. ARMA is willing to work with EPA to help devise an averaging system that is flexible, yet at the same time ensures compliance with the MACT standards.

There is ample precedent for averaging to meet MACT standards. For example, in the MACT standards for primary aluminum reduction plants, EPA permitted facilities to average emissions among distinct defined sources, "potlines" and furnaces. 62 Fed. Reg. 52384, 52387-88 (Oct. 7, 1997), codified at 40 CFR part 63, subpart LL. Thus, a facility may elect to meet the emission limits for individual potlines and furnaces found in 40 CFR §§ 63.843 and 63.844. Alternatively, it may elect to comply through emissions averaging under §63.846, which states in subsection (a) that the owner or operator "*may demonstrate compliance by emissions averaging according to the procedures in this section*" (emphasis added). In the MACT standards for the synthetic

organic chemical manufacturing industry (SOCMI) and other industries, EPA has also defined the “source” to be the entire facility, and allowed emissions averaging among units. See 40 CFR 63.150.

Startup, Shutdown, and Malfunction Provisions

ARMA supports the proposal’s provisions ensuring that a facility will not be in violation of the asphalt roofing MACT standards during a startup, shutdown, or malfunction (SSM) event, as long as the facility operates in accordance with its SSM plan. See §§ 63.8685(a) and 63.8691(d). In addition to being wise policy, and consistent with §§ 63.6(e) and 63.7(e)(1) of EPA’s “General Provisions” for 40 CFR part 63, this SSM provision is almost certainly required as a legal matter. Courts have acknowledged that technology is bound to fail at times, and technology-based standards such as MACT standards must account for such inevitable failures. See, e.g., *Essex Chem. Corp. v. Ruckelshaus*, 486 F.2d 427, 432 (D.C. Cir. 1973).

VI. Performance Testing

We think the rules need to be clarified to better indicate that facilities may conduct their performance testing with a product that is expected (based on a knowledge of the manufacturing process) to result in the highest asphalt emissions per ton of asphalt processed. EPA should also amend the rules to allow performance testing to be conducted by the later of (1) the first August 15 following the compliance date for existing sources, or (2) 180 days following the compliance date for existing sources.. EPA should also include provisions that allow facilities to use qualified data from previous testing in lieu of conducting all or part of a performance test.

Operations During Performance Testing

The proposal appears to be inconsistent on the conditions under which facilities are to conduct their performance tests. The preamble suggests that the performance test should be performed under “normal operating conditions” and “operating conditions that reflect the highest rate of asphalt processing or roofing production reasonably expected to be achieved by the facility” (p. 58614, col. 2). Table 3 in the actual proposed rules sets forth the requirements for performance tests; it specifies particular conditions that seemingly would apply across-the-board to different facilities that produce different products. For example, the table states, “If the product is shingle or mineral-surfaced roll roofing, tests must be conducted while a nominal 106.6 kg (235 lb) shingle is being produced.” Table 3 to Subpart LLLLL, item 6, final column, at p. 58634. Many facilities do not even manufacture these two products. The table also prescribes the type of saturated felt or fiberglass shingle that is to be used, regardless of the type of product actually manufactured at the facility. *Id.*

Table 3 needs to be revised to reflect the basic approach stated in the preamble. It is important that facilities be allowed to conduct the performance test using a product manufactured at the facility (or that may be manufactured there) that is expected (based

on a knowledge of the manufacturing process) to result in the highest asphalt emissions per ton of asphalt processed.

Timing of the Performance Test

We are perplexed about why EPA believed it necessary to require the performance test for existing sources to be conducted *before* the asphalt roofing MACT compliance date. The General Provisions and nearly all previously-issued MACT standards allow the test to be carried out 180 days following the compliance date for existing sources, and within 180 days of startup for new sources. 40 CFR §63.7(a)(1)-(2). Yet §63.8686(a) of the proposed asphalt roofing MACT standards requires existing facilities to conduct their performance tests “no later than 60 days prior to the compliance date...”

This earlier date – eight months earlier than provided for under the part 63 General Provisions – would create several problems. First, it would not provide adequate time to work through normal “shakeout” problems following installation of the control and monitoring equipment. Perhaps most important, it would restrict the season during which the facility can conduct its performance test. Companies cannot be expected to be operating in compliance until very close to the compliance date. Yet if the compliance date (the date three years following publication of the final rules) is in the winter, spring or early summer, facilities will be forced to carry out their compliance test when it is cold or cool outside. Testing under these conditions raises safety concerns for the stack testing crew. Furthermore, because the operating limits for PM control devices require that the facility not exceed a specified maximum temperature, it will be necessary to conduct the test during the summer if the facility is to avoid being thrown into noncompliance during the summer months because the maximum temperature can be affected by the ambient temperature. Just as facilities must be able to conduct the performance test using the product that is expected to result in the highest asphalt emissions (see discussion above), they also must be able to conduct the test during the time that presents the worst compliance situation; *i.e.*, the hotter months of the year. Thus, ARMA members need flexibility on the timing of the performance test.

The MACT rules can provide this necessary flexibility by allowing the performance test to be conducted by the later of (1) the first August 15 following the compliance date for existing sources, or (2) 180 days following the compliance date for existing sources. The second alternative will allow facilities to “work out the bugs” after the installation of new control equipment, computers, and software, in the event that the compliance date is in the spring or summer prior to August 15. At the very least, facilities should be given the opportunity to carry out their performance test within 180 days following the compliance date for existing sources, and within 180 days of startup for new sources – the approach used in the “General Provisions” for §112 and many other MACT rulemakings.

For these reasons, and because EPA has acted differently in this proposal than in the part 63 General Provisions and other MACT standards – without providing a rational

explanation for such a differential treatment – the proposed performance test deadline provision is arbitrary. The agency should rewrite §63.8686(a) to state the following: “For existing affected sources, you must conduct performance tests no later than (1) the first August 15 following the compliance date that is specified for your source in § 63.8683, or (2) 180 days following such compliance date.”

Allowing the Use of Data In Lieu of Testing

If a facility previously has conducted testing under conditions similar to those that would be used in the performance test, there is no need to conduct expensive duplicative testing. Instead, the rules should provide that previous test data conducted under conditions that meet EPA testing requirements may be used in lieu of conducting all or part of a performance test. EPA has followed this approach in other MACT rules. See, e.g., 40 CFR §63.1207(c)(2) (hazardous waste combustor MACT standards).

We recognize that EPA will need to specify what types of data may be used in this way. We suggest requiring that the previous tests either (1) have been conducted for regulatory purposes, or (2) meet EPA testing criteria. As long as the tests also were conducted under conditions (for type of product, etc.) similar to that required under the performance test requirements of the MACT standards, EPA should allow the data to be used in lieu of data derived from a performance test conducted expressly for MACT compliance.

VII. Monitoring, Recordkeeping, and Reporting

Decision Not To Require Use of CEMS or COMS

EPA explains in the proposal that monitoring of control device parameters to determine compliance with operating limits will ensure compliance with the asphalt roofing MACT standards (p. 58623, col. 2). We agree. ARMA also agrees with EPA that requiring the use of CEMS and COMS would be unreasonable and unnecessary.

The proposal specifically requests comment on “including a provision in the NESHAP to allow facilities to use CEMS and COMS as options to parametric monitoring.” *Id.* We believe it would be useful to include such a provision. If a facility elects to use a CEMS or COMS, it should be allowed to do so. In such cases, the part 63 General Provisions regarding the use of CEMS and COMS should apply.

Option to Allow Use of Chart Recorder

The computers and other equipment necessary to comply with the parameter monitoring provisions of the proposal will be expensive. We believe that facilities should be given the option of using a less expensive chart recorder if they are willing to accept what essentially would amount to more stringent compliance requirements.

The proposal provides for 3-hour averaging periods when measuring combustion zone temperature at thermal oxidizers and inlet gas temperature and pressure drop at PM

control devices. Data must be collected every 15 minutes to establish these 3-hour averages. Proposed §63.8688, and Tables 2, 3, and 5 to Subpart LLLLL. Thus, measurements at a number of the 15-minute data points can exceed the numerical value of the operating limit, as long as the 3-hour average does not exceed this value. We suggest giving facilities the option of using less expensive chart recorders if they are willing to accept that exceedance of the numerical value of the operating limit for any 15-minute data point will be treated as a “deviation”. Again, this effectively makes the standard more stringent because the averaging period would be eliminated under the option. Facilities that are willing to operate in this way to avoid the cost of expensive monitoring equipment should be given the option to do so.

Electrostatic Precipitators

The proposal requires a facility that decides to use an electrostatic precipitator (ESP) as a PM control device to monitor both the inlet gas temperature and pressure drop to determine compliance. See Table 2 to Subpart LLLLL. The facility should not necessarily be required to monitor both these parameters if it uses an ESP. For example, monitoring temperature alone is often adequate to demonstrate that an ESP is functioning properly, thus ensuring compliance with the standards.

EPA should modify the rules so that a facility using an ESP as a PM control device can select which parameters are appropriate for demonstrating compliance. EPA then would need to approve these parameters, as is the case for “other” control devices covered under item 3 of Table 2 to Subpart LLLLL. Thus, Table 2 should distinguish between filter-type PM control devices (to be included under item 2) and ESPs (to be included under item 3). The “For” column⁹ of item 2 should read “Filter-type particulate matter control device.” The “For” column for item 3, should read: “Electrostatic precipitators and all other control devices other than thermal oxidizers or filter-type particulate matter control devices.”

Using Manufacturer Specifications For Differential Pressure

For measuring differential pressure to demonstrate compliance with a PM operating limit, facilities should be allowed to *either* develop a differential pressure monitoring parameter during a performance test (as the proposed rules require), *or* simply follow manufacturer specifications for the control device. Allowing facilities to choose the second option is important because the functionality of a filter-type PM control device (e.g., fume filter) is defined by the filter manufacturer in terms of an operating range for differential pressure. Operating the unit within these operating ranges – which will require timely replacement of filters, as well as proper operation and maintenance of the unit – will result in compliance with the MACT standards. As we discuss below, the requirements found in item 2 of Table 3 therefore should be rewritten. Making these

⁹ Our proposal to change the requirements for facilities that use filter-type PM control devices is discussed immediately below.

changes will significantly reduce the cost of compliance, while still ensuring that the MACT emission limitations are met.

Following the evaluation of the airstreams at a source, the manufacturer of a filter-type particulate matter control device can provide an operating range of differential pressure for each specific application. Currently, filter-type PM control devices are guaranteed by the manufacturer to deliver both opacity and PM control in compliance with the emission limitations in the asphalt roofing MACT proposal. This compliance is guaranteed at a pressure drop up to ten inches of water. The filters in the filter-type PM control device usually last several years before reaching the pressure drop limit. Plants change out filters at some level below the limit so as to assure compliance even though the technology can deliver compliance at pressure drop levels greater than the guarantee.

As proposed, the MACT requirements would force the facility into one of several possible alternatives. Unless the deadline for conducting a performance test corresponded to the end of the filter life in a filter-type PM control device, the facility would have to test at a pressure drop below the manufacturer's guarantee due to the testing deadline – something that should not be done. Then, once the operating pressure drop reached the testing pressure drop, the facility would have to replace the filters even though the filter-type PM control device would ensure compliance with the standards well into the future.

Filter replacement can cost \$100,000 per event. If testing is done shortly after replacement, and the filters have to be replaced based on the testing pressure drop, the associated added costs would be enormous even though there would be no corresponding increase in HAP removal. Alternatively, the facility would need to initially test the filter-type PM control device to meet the deadline. If it wished to use the filters for their entire life it then would have to petition EPA and/or the state agency to go beyond the test pressure drop, and then bear the significant costs of re-testing.

The performance testing requirements as proposed therefore do take into account the actual operating methodology of the filter-type PM control devices. They also penalize the facility for using a technology shown to deliver compliance. To recognize the operating methodology of the filter-type PM control device the following method of determining operating parameters should be used.

As recognized by NSPS Subpart UU, the temperature of the influent emissions stream is more critical than the operating pressure drop to assure compliance. Thus, as long as the filter-type PM control device pressure drop is within the specifications recommended by the manufacturer, MACT performance testing of filter-type PM control devices should only require monitoring of influent emissions temperature. This would make the MACT rules consistent in approach to that found NSPS Subpart UU, and would still assure compliance with the MACT standards.

As is the case under NSPS Subpart UU, as long as the operating influent emissions temperatures are within a reasonable percentage considering the range of ambient temperature variation (*e.g.*, 10 percent) above the temperatures during performance testing, the facility would be considered in compliance. If the operating influent emissions temperatures are greater that percentage above the temperature during

performance testing, EPA and the state would have the discretion to either (1) require re-testing or (2) allow the facility to continue operations based on the results of the original performance testing. EPA should also allow the facility to delay any re-testing until the hottest part of the summer to prevent the facility from having to conduct additional tests due to the increase in ambient air temperature and the results on the influent emissions stream temperature. See discussion in section VI above on the timing of the performance test.

Thus, EPA should revise §63.8687(a) of the proposed standards to include the following underscored language: “You must conduct each performance test in Table 3 of this subpart that applies to you, except that instead of establishing differential pressure and temperature operating limits for a particulate matter control device, you may elect to establish the operating limit as the manufacturer’s differential pressure specifications for the device.” Table 2 to Subpart LLLLL also should be modified by revising the second column for “2. Particulate matter control device” to read as follows:

- a. Maintain the 3-hour average inlet gas temperature at, below, or within a reasonable percentage above (considering the range of ambient temperature variation) the temperature recorded during the performance test; and
- b. Maintain the 3-hour pressure drop across the device at or below the operating limit established: (1) during the performance test; or (2) pursuant to the manufacturer’s specifications, as described in §63.8687(a).

VIII. Health Effects Discussion in Preamble

For the record, ARMA believes that much of the proposal’s discussion of health effects resulting from exposure to HAP (pp. 58612-13) is misleading. We realize that in different MACT preambles EPA generally uses the very same boilerplate language for health effects from exposure to HAP. Still, the title of the preamble section is “What Are the Health Effects Associated With the Asphalt Processing and Asphalt Roofing Manufacturing Source Categories?” (p. 58612, col. 2). We therefore believe EPA has an obligation to be accurate, and to consider the low emissions, low concentrations, and resulting minimal exposure associated with nearly all HAP emitted from asphalt processing and asphalt roofing manufacturing operations.

We have already discussed (in section II of these comments) that there are no reliable data suggesting that hexane is emitted from asphalt processing or asphalt roofing manufacturing operations. Furthermore, acute exposures at very high levels of hexane are needed to produce the central nervous system and neuromuscular effects described in the preamble. Even if minute amounts of hexane were emitted from the facilities of ARMA members, the concentrations would be so minimal that none of the health effects described in the preamble would occur.

Similarly, the discussion of health effects associated with formaldehyde and the other HAP bears no relationship to the limited exposure to these substances resulting from emissions at asphalt processing and asphalt roofing manufacturing facilities. Again, many of the effects described are associated only with acute exposures. EPA should recognize these important points in the preamble to the final rule.

IX. Conclusion

Again, ARMA appreciates EPA's willingness to listen to the concerns of ARMA and its member companies. The asphalt roofing MACT standards will have a substantial impact on our industry, and we encourage EPA to carefully study these comments in order to improve the final rule.

Attachment 1

**Asphalt Roofing Manufacturers Association**

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Thursday, September 17, 1998

Juan Santiago
U.S. Environmental Protection Agency
North Carolina Mutual Building
411 West Chapel Hill Street, 8th Floor
Durham, NC 27701

Via Overnight Mail:


Subject: Enter Subject Matter

Dear Mr. Santiago:

Enclosed please find an ARMA report addressing EPA's June 11, 1997 emission inventory of section 112 (c)(6) pollutants. It is our understanding that because EPA had limited available data to make its findings, the agency used Polynuclear Hydrocarbons as a substitute for Polycyclic Organic Matter. This assumption resulted in the Roofing Manufacturing and Asphalt Processing Industry being included as a source of Polynuclear Aromatic Hydrocarbons (PAH).

The enclosed draft report is for your review and will be discussed at our September 23, 1998 meeting at your offices. We would like your opinion at that time as to the best way to proceed in possibly eliminating the Asphalt Roofing Manufacturing and Asphalt Processing Industry from being included as a source of PAH's under this regulation.

Respectfully,


Russell K. Snyder
General Manager

cc: ARMA Environmental Task Force
Wendell Alcorn, Jr., CWT
David Novello, FLKF



***Polyaromatic Hydrocarbon Emissions
From Asphalt Processing and Roofing Manufacturing
Operations***

***Submitted by
Asphalt Roofing Manufacturers Association
Environmental Task Force
September 1998***

Abstract

The Clean Air Act of 1990 Section 112(c)(6) requires EPA to identify and regulate 90% of the sources of Polycyclic Organic Matter (POM). The Roofing Manufacturing and Asphalt Processing industry segments of the Asphalt Roofing Industry have been identified in EPA's emission inventory as sources of POM's. EPA utilizes Polyaromatic Hyrdocarbons (PAH) as a surrogate for POM's. EPA's estimate of PAH emissions overstates the industry production and their emission factors are based on limited data. This resulted in significant overestimation of the industry PAH emissions. This paper presents revised emission estimates for these industry segments. The industry estimate suggests that the PAH emissions for the Asphalt Roofing Industry are less then 3% of those estimated by EPA.

Background

The reduction of emissions of Hazardous Air Pollutants (HAP) in the United States has been mandated by Section 112 of the Clean Air Act, as amended in 1990. This section of the Clean Air Act contains the original listing of 189 HAP's in Section 112-(b) (1). The Administrator of the EPA published the list of industry sources of Hazardous Air Pollutants pursuant to section 112(c) of the act and EPA is required to establish Maximum Achievable Control Technology (MACT) standards for the major Sources of HAPs in the identified industry segments. A major source is defined as any facility source that has the potential to emit 10 tons per year of any individual HAP or 25 tons per year in the aggregate of all HAPs. The Asphalt Roofing Industry was included in EPA's list of the industrial sources of HAPs₍₁₎. The timing for the Asphalt Roofing Industry MACT standards is the year 2000. ⁽²⁾ The Asphalt Roofing Manufacturers Association (ARMA) is currently working with EPA in the development of these MACT standards.

In addition to the above sections, Section 112(c)(6) of the Clean Air Act identifies seven pollutants as being subject to special provisions for MACT standards. EPA is required to list the sources of these pollutants and assure that sources accounting for at least 90% of the emissions are subject to standards under Section 112(d)(2) or Section 112(d)(4).

Table 1

Section 112(c)(6) Pollutants
Alkylated lead compounds
Polycyclic Organic Matter
Hexachlorobenzene
Mercury
Polychlorinated Biphenyls
2,3,7,8-tetrachlorodibenzfurans
2,3,7,8- Tetrachlorodibenzo-p-dioxin

EPA prepared an emission inventory of section 112(c)(6) pollutants as required by the act. This emission inventory was issued on June 11, 1997. ⁽³⁾ In the emission inventory, EPA used PAH as a surrogate for POM. The Asphalt Roofing Industry is included in this emissions inventory as a source of PAH's. Inclusion in this listing opens the door for further regulation of industry sources.

EPA's mandate to control 90% of the emissions of Section 112(c)(6) sources allows EPA to include area (non-major) sources of these pollutants in the MACT regulations for each industry. EPA has recently utilized the same emission inventory prepared for section 112(c)(6) as input to their inventory of 40 pollutants subject to possible regulation under section 112(k). Section 112(k) requires EPA to regulate area sources to insure that at least 90% of the emissions of 30 HAPs presenting health threats to urban population are regulated.

The ARMA Environmental Task force, faced with the possibility of MACT regulation on area sources of the Asphalt Roofing Industry, and the inconsistencies in the EPA estimates, utilized recent industry data to prepare a more accurate estimate of PAH emissions.

EPA 1990 Baseline Emission Estimate

The EPA 1990 Baseline Emission Estimate of 112(c)(6) Pollutants make several significant assumptions. EPA redefines the family of compounds to be regulated from Polycyclic Organic Matter to Polynuclear Aromatic Hydrocarbons. PAH's are a narrower subset of the POM group. EPA suggests the use of PAH 7 and PAH 16 groups as possible surrogates for total POM emissions. EPA states that the species that make up the PAH 7 group are probable human carcinogens. The PAH 16 group are those species measured by EPA Method 610. The members of the PAH7 and PAH 16 groups are listed in the Table 2.

Table 2

PAH 7 Group	PAH 16 Group
Benz(a)anthracene	Acenaphthene
Benzo(a)pyrene	Acenaphthylene
Benzo(b)fluoranthene	Anthracene
Benzo(k)fluoranthene	Benz(a)anthracene
Chrysene	Benzo(a)pyrene
Dibenz(a,h)anthracene	Benzo(b)fluoranthene
Indeno(1,2,3-cd)pyrene	Benzo(ghi)perylene
	Benzo(k)fluoranthene
	Chrysene
	Dibenz(a,h)anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-cd)pyrene
	Naphthalene
	Phenanthrene
	Pyrene

EPA's estimate of Asphalt Roofing Industry 1990 PAH emissions was 1.68 tons of PAH 7 per year and 43.6 tons of PAH 16 per Year.

These estimates combined PAH emissions for both Asphalt Processing and Roofing Manufacturing segments. The estimates are presented on page B-47 of the "1990 Emission Inventory of Section 112(c)(6) Pollutants" Final Report June 1997, Distributed by the Emission Factor and Inventory Group (MD-14), Emissions, Monitoring and Analysis Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Due to several errors in input data, these EPA estimates are many times higher than the more detailed estimates described in the remainder of this paper. EPA does not document the source of their emission factors for both Asphalt Processing and Roofing Manufacturing. The Asphalt Processing emission factor is several orders of magnitude above industry experience. The Roofing Manufacturing emission factor does not differentiate between organic and inorganic substrates. In addition, EPA's estimate of industry production is flawed by a units error in reporting the industry shingle production and an overestimate of the asphalt content in roofing to determine the asphalt production.

ARMA Industry Estimate

The ARMA estimate of industry PAH emissions was prepared from data collected from an ARMA study conducted at a member company's manufacturing plant during an ARMA sponsored sampling event in August 1995. Additional data was provided by Owens Corning. This Owens Corning data had been collected to prepare Title V permit applications. Both the ARMA and Owens Corning data has presented in tables 3 and 4. This data is presented as pounds of pollutants emitted per ton of product produced. The emissions factors for asphalt processing are **controlled** emissions. Controlled emissions are representative of the Asphalt Processing segment as incinerators or afterburners are in place on 100% of all manufacturing facilities.

The emission factors presented for the Roofing Manufacturing portion of the business are **uncontrolled** emissions. There is no representative control scheme for this industry segment. The Roofing Manufacturing segment includes, no control on many fiberglass coaters, numerous methods of particulate control and in some instances incineration of coater or saturator fumes. Since the control efficiency for PAH's is unknown for these devices, the uncontrolled emissions for the Roofing Manufacturing segment were used.

Table 3

PAH Emission Factors- Asphalt Air Blowing ⁽⁷⁾

PAH Compound	PAH 7/16	1990 Baseline	OC Plant C	OC Plant L Ferric	OC Plant L No Ferric	OC Plant Q Cutter	OC Plant Q #5 Fuel
Acenaphthene	16	x	0	3.60E-05	2.50E-06	2.70E-07	8.40E-08
Acenaphthylene	16		6.70E-09			2.50E-08	6.70E-09
Anthracene	16		0			2.50E-09	5.60E-08
Benz(a)anthracene	7	x	0			8.00E-09	6.20E-09
Benzo(a)pyrene	7		0				
Benzo(b)fluoranthene	7		0			7.10E-09	7.90E-09
Benzo(ghi)perylene	16		0				
Benzo(k)fluoranthene	7		0				
Chrysene	7	x	0			1.00E-08	1.40E-08
Dibenz(a,h)anthracene	7		0				
Fluoranthene	16	x	0	1.30E-05	2.50E-06	6.50E-09	2.00E-08
Fluorene	16						
Indeno(1,2,3-cd)pyrene	7		0				
Naphthalene	16		5.90E-06	5.30E-05	2.50E-05	8.90E-07	9.90E-07
Phenanthrene	16	x	0	8.00E-05	6.90E-06	6.40E-08	6.40E-07
Pyrene	16		0	7.30E-06	2.50E-06	7.80E-09	1.80E-08
PAH 7 Factor		0	0	0	0	2.51E-08	2.81E-08
PAH 16 Factor		5.10E-03	5.91E-06	1.89E-04	3.94E-05	1.2909E-06	1.8428E-06
			Average	Maximum			
PAH 7 Factor			1.06E-08	2.66E-08			
PAH 16 Factor			4.75E-05	1.89E-04			

There is a growing number of Asphalt Industry sampling events where the PAH 7 group and certain members of the PAH 16 organics have not been detected. Results below detection limit from these sampling events were set at zero when calculating the industry average emission factors. A second set of emission factors were derived using the worst case sampling event and adding in the non detect compounds at the level of detection. These are particularly conservative estimates, considering that the EPA estimates were based on only five species with the remaining compounds set at zero ⁽⁴⁾. These numbers are shown as the industry maximum numbers for both fiberglass and organic roofing manufacture.

Table 4

PAH Emission Factors- Roofing Manufacturing (10) (11)

PAH Compound	PAH 7/16	EPA 1990 Base	OC Plant Fiberglas	ARMA Fiberglas @Detection	ARMA Fiberglas	ARMA Organic@ Detection	ARMA Organic
Acenaphthene	16	x	0.00E+00	2.56E-06	2.56E-06	2.28E-05	2.28E-05
Acenaphthylene	16		0.00E+00	1.605E-06	0	1.03E-05	0.00E+00
Anthracene	16		0.00E+00	2.476E-06	2.476E-06	4.35E-05	4.35E-05
Benz(a)anthracene	7	x	0.00E+00	5.384E-06	0	4.81E-05	0.00E+00
Benzo(a)pyrene	7		0.00E+00	9.687E-06	0	8.00E-05	0.00E+00
Benzo(b)fluoranthene	7		0.00E+00	8.257E-06	0	6.65E-05	0.00E+00
Benzo(ghi)perylene	16		0.00E+00	1.193E-05	0	9.85E-05	0.00E+00
Benzo(k)fluoranthene	7		0.00E+00	8.672E-06	0	7.16E-05	0.00E+00
Chrysene	7	x	5.55E-06	5.873E-06	0	6.23E-05	0.00E+00
Dibenz(a,h)anthracene	7		0.00E+00	1.284E-05	0	1.07E-04	0.00E+00
Fluoranthene	16	x	0.00E+00	3.421E-06	3.421E-06	2.76E-05	2.76E-05
Fluorene	16		6.35E-06	1.261E-05	1.261E-05	1.29E-04	1.29E-04
Indeno(1,2,3-cd)pyrene	7		0.00E+00	9.924E-06	0	8.19E-05	0.00E+00
Naphthalene	16		5.55E-06	1.268E-05	1.268E-05	9.32E-05	9.32E-05
Phenanthrene	16	x	6.18E-06	1.589E-05	1.589E-05	2.52E-04	2.52E-04
Pyrene	16		1.05E-06	4.266E-06	4.266E-06	5.28E-05	5.28E-05
PAH 7 Factor		1.10E-04	0.00000555	6.064E-05	0	0.0005171	0
PAH 16 Factor		3.17E-04	0.00002468	0.0001281	5.39E-05	0.00124656	0.00062064
		Max	Average				
Fiberglas PAH 7		6.0638E-05	2.775E-06	lb/ton			
Fiberglas PAH 16		0.00012807	3.929E-05	lb/ton			
Organic PAH 7		0.0005171	0	lb/ton			
Organic PAH 16		0.00124656	0.00062064	lb/ton			

Since emission factors were derived for asphalt processing, fiberglass roofing and organic roofing, production estimates for each industry segment were required to obtain a comprehensive industry emissions estimate. The Asphalt Processing segment production data was obtained from the industry estimates of asphalt oxidation (8). These estimates include not only saturant and coating asphalt for roofing manufacturing, but Built Up Roofing Asphalts and Industrial Specialties produced by the industry. The Roofing Manufacturing Segment production data were taken from the Asphalt Roofing Manufacturers reports of industry shipments.

These reports cover production for the years 1995-1997. The industry production estimates and subsequent PAH emissions are provided in Tables 5 & 6. The comparison of these estimates to the EPA 1990 baseline is shown in Figures 1-3. The ARMA emissions estimates were not revised downward for 1990 even though the total production output of the industry has increased by 10% from 1990 to the 1995-1997 period.

Table 5
Asphalt Processing Emissions

1997 Built-up Roofing Asphalt Production- Tons ₍₉₎	1,100,000
1997 Roofing Saturant and Coating Asphalts- Tons ₍₉₎	4,200,000
1997 Industrial Specialty Asphalts- Tons ₍₉₎	500,000
1997 Total Asphalt Processing Tons	5800000

Emissions Factors- Lb. per Ton of Product	Average	Maximum
PAH - 7	1.064E-08	2.66E-08
PAH - 16	4.74881E-05	1.89E-04

1997 Asphalt Processing Emissions- Tons Emitted		
PAH - 7	3.086E-05	7.714E-05
PAH - 16	1.377E-01	5.481E-01

Table 6
Roofing Manufacturing Emissions

Annual Roofing Production- Tons ₍₈₎	Inorganic 1.28E+07		Organic 2.51E+06	
Emission Factors - Lbs/Ton	Inorganic Average	Inorganic Maximum	Organic Average	Organic Maximum
PAH - 7	2.78E-06	6.06E-05	0.00E+00	5.17E-04
PAH - 16	3.93E-05	1.28E-04	6.21E-04	1.25E-03
Annual Roofing Production Emissions-Tons				
PAH - 7	0.02	0.39	0.00	0.65
PAH - 16	0.25	0.82	0.78	1.56

Discussion

The total emissions from the Asphalt Roofing Industry Manufacture and Asphalt Processing Industry are less than 3% of the emissions estimated by EPA. The key difference between the ARMA estimate of PAH emissions and the EPA baseline was the estimate of emissions attributable to Asphalt Processing. The EPA baseline differs from the industry estimate in both magnitude of the emission factor and industry throughput. The basis for the EPA emission factors was not documented.

EPA has stated both in the baseline emission estimate ⁽⁴⁾ document and in their discussion of comments on the April 10, 1998 Federal Register publication ⁽²⁾ of the final recommendations that their emission estimates were derived from sparse and questionable data. EPA also acknowledges that the data collected for MACT standard development will be of higher quality and more

representative. This is apparently the case for the Asphalt Roofing Industry POM emission estimates also.

In the EPA estimate, the total industry asphalt processing production was estimated as one half the total roofing production. This was based on the erroneous assumption that asphalt makes up 50% of the weight of roofing products. Offsetting somewhat the over estimate of asphalt going into roofing, is the failure to count any asphalt production to other products such as BURA and Industrial Specialties. The ARMA estimate of controlled emissions, based on actual industry data, for the Asphalt Processing Segment is a fraction of a ton annually for even the worst case maximum (as shown in Tables 5 & 6).

The EPA estimate for Roofing Manufacturing Segment was skewed by an apparent conversion error from roofing squares to production tons. The EPA estimate of 1990 roofing production exceeds the Industry estimate of annual production for the 1995-1997 period. ARMA estimates that the PAH 16 emissions from uncontrolled coater and saturator sources is 1 ton annually, based on the average PAH 16 emissions in Table 6.

The generation of PAH 7 is negligible for the industry as a whole. Additionally, PAH emissions from the roofing manufacturing segments are uncontrolled emissions. These numbers will be further reduced by the control measures currently in place and future MACT standards for major sources in the industry. Further reductions by controlling area sources will have no measurable impact on the aggregate emissions of PAH's in the United States. Thus, there is no reason to regulate the Asphalt Roofing Industry for POM's.

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11. Owens Corning. Report on Diagnostic Testing Coater Outlet Reference No. EAD94008 Clean Air Engineering November 1994

Attachment 2

Attachment 2

May 4, 2000

Mr. Juan Santiago
U. S. Environmental Protection Agency
Emission Standards Division
(MD-13)
Research Triangle Park, NC 27709
919/541-1084 919/541-5600 (fax)

Subject: ARMA FTIR Data

Dear Mr. Santiago,

In response to the correspondence received on April 6, 2000 from our ARMA contact, Russell Snyder, we have prepared the following reply to address the data quality concerns raised in the two internal Eastern Research Group (ERG) memos dated November 10 and 11, 1999.

As scientists involved in data collection with significant impacts to the regulated community, we understand the importance and benefits of the peer review process. Unfortunately, this peer review was performed without the benefit of communication between Enthalpy and the reviewer, and resulted in several misunderstandings and incorrect conclusions that could easily have been avoided.

ERG's review was performed by Dr. Jeff LaCosse. The main conclusions of his review were based on two problems he observed in the spectra: double modulation (DM) and an unspecified "instrument electronics problem." In the Memo Dated November 11, 1999, Dr. LaCosse wrote: "As stated in yesterday's memorandum, the presence of DM invalidates all the spectral data in question. This is simply due to the fact that DM adds spurious, or false, spectral lines which may be *erroneously* quantified as a target analyte." He goes on to say that "Depending on the wavenumber regions used for analysis, this anomaly will introduce *significant* quantitation errors in the analysis of some of the species, including formaldehyde."

We strongly disagree with these conclusions, and contend that they could not have resulted from a careful, unbiased review of the test data submitted to Dr. LaCosse.

One of Dr. Lacosse's primary concerns is instrument-related double modulation. We provided the LaCosse memos to the instrument manufacturer (MIDAC Corporation of Irvine, California) and have attached their response. MIDAC is a well known, highly respected FTIR instrument manufacturer, and provided four of the five Fourier transform infrared (FTIR) analyzers used to collect the data provided to Dr. LaCosse. MIDAC's response was written by the President of MIDAC, Dr. Gerald Auth, and MIDAC's Senior Applications Engineer, Mr. Brian Wright. Mr. Wright assisted in the analytical method development, and also participated in one of the ARMA field tests. The Midac response clearly addresses the double modulation issue and demonstrates that its effect on the data quality is negligible.

As noted in the MIDAC response, the DM is attributed to the relatively high reflectivity of the zinc-selenide (ZnSe) gas cell windows selected for this project. We were aware of the potential problems associated with this material and addressed the issue in each site-specific test protocol. ZnSe windows with anti-reflective coatings were chosen for the ARMA tests because of their durability, non-hygroscopic nature, and chemical inertness. Other choices of window materials, such as potassium bromide or potassium chloride, would have reduced the DM effect. However, these materials are hygroscopic and/or reactive with various gaseous compounds; their use in stack-testing applications often leads to increased instrument downtime and decreased infrared energy throughput.

Dr. LaCosse's review suggests the effect of the DM on the concentration data are significant. However, his review contains no calculations to support this suggestion, despite the fact that he possessed all the data necessary for such calculations.

Had Dr. LaCrosse examined the supporting data and performed the simple calculations required to support his (erroneous) conclusions, he would have noted the following facts. While the spectral region affected by the DM is the same region used in the HCl and formaldehyde analyses, our field-test and analytical procedures largely prevented DM-related effects on the reported measurements of these compounds. Enthalpy's standard operating procedure requires collecting water reference spectra (while on-site) with the field instrument for use in the classical least squares (CLS) analysis. The CLS algorithm accounts for all known interfering absorption features, including those of water. Because the double modulation features are present in the water reference spectra, the software scales and subtracts the double modulated peaks as if they were actual water absorbance features. These DM-related features therefore have very little, if any, effect on the quantitative results.

Furthermore, the analytical software does not produce false positives, nor does it report falsely detected target analytes. The presence of all the compounds reported as "detected" were confirmed by visual examinations of the entire mid-infrared range, including the "fingerprint" region spectrum which is wholly unaffected by double modulation. It is simply not possible that the presence of a small number of spurious, low-amplitude peaks in an isolated spectral range could result in any incorrect compound identifications.

Dr. Lacosse's other primary concern involved the strange appearance of some of the spectra he chose to examine (see Figure 1 and Figure 2 of his review). He attributed this appearance to "an instrument electronics problem." In fact, *the spectra shown in these Figures are **not** sample spectra, and were **not** used to determine the reported compound concentrations.* In reality, the spectra in the Figures are "residual spectra" – that is, they are sample spectra from which scaled reference spectra have been subtracted in the spectral regions selected for CLS analysis. Dr. LaCosse's inferences that these spectra are related to some unspecified "baseline anomaly" and to the reported analyte concentrations are simply incorrect.

Finally, Figure 3 of Dr. Lacosse's memo contains a partially saturated absorbance spectrum – that is, the spectrum of a sample which has absorbed all of the infrared energy in some important spectral regions. Such spectra are often encountered during FTIR testing at this type of emission source. We recognized this problem during the field test in question, and immediately instituted sample dilution procedures to prevent it. Again, none of the saturated spectra Dr. LaCosse chose to include in his Figures were used to generate the reported analyte concentrations.

The data sent to ARMA by Enthalpy included all of the spectra collected during the project, including spectra that were not used in the final calculations. This is in keeping with the common quality assurance practices of archiving all the data generated on site and not disposing of any data. If these data are subject to additional review, we recommend that the reviewer not "randomly [choose] spectra from each directory," as Dr. LaCosse did. Rather, the reviewer should consult the provided field data sheets and consider only those spectra which are actually related to the reported results.

In conclusion, the FTIR concentration results provided to ARMA by Enthalpy are accurate and reliable. In fact, they meet or exceed all of the data quality objectives required for this project.

Sincerely,

Peter G. Zemek, Ph.D.
FTIR Group Director

Steven J. Eckard, P.E.
President

Enclosures:

cc: Russell K. Snyder, ARMA
Walter S. Smith, Walter Smith & Associates
Gerald Auth, MIDAC Corporation
Grant Plummer, Rho Squared
Tom Geyer, MRI
Stan Wolfersberger, Owens-Corning

Attachment 3



17911 FITCH AVENUE, IRVINE, CA 92614
TEL: (949) 660-8558 FAX: (949) 660-9334

April 11, 2000

Enthalpy Analytical
PO Box 31995
Raleigh, NC 27604

Ph: 919-850-4392
Fx: 919-850-9012

Attn: Pete Zemek, Todd Grosshandler

This letter is in response to the series of faxes sent to MIDAC on 4-6-00 regarding the FTIR measurements taken by Enthalpy Analytical in 1999. Comments written here are in response to two of these faxes, both written by J. LaCosse on 11-10-99 and 11-11-99 and will be referred to as *fax1* and *fax2* respectively.

The main point Dr. LaCosse presents is an optical phenomenon known as double modulation (DM). This occurs when IR light reflects off of a surface in the optical path and gets remodulated in the interferometer causing *ghost peaks* to occur at 2x the correct wavelength. Dr. LaCosse also mentions instrument electronic problems. Our interpretation of the information is that the DM is present but is not truly detrimental as to "invalidate all the spectral data." Also, there was not an electronics problem that caused baseline anomalies. We will address these two issues in detail below.

Electronics problem. In *fax1*, the baseline anomalies are portrayed in Figures 1 and 2. These spectra are not likely to be absorbance spectra (with *.abs extensions). Rather they are residual spectra (*.rsd). The AutoQuant software uses a classical least squares algorithm for analysis. Part of the analysis includes generating a residual spectrum for each sample spectrum. The residual spectrum is the sample spectrum minus the reference spectra in all regions of analysis. It is very normal to see these disjointed baselines especially when several different regions of analysis are used.

Double modulation. This is not a new problem for FTIR manufacturers, especially for those who use ZnSe optics in the system. As with most choices, there are positive and negative aspects with each choice. ZnSe is a very strong non hygroscopic optic and is very robust in hot, wet stack samples. This is the preferred choice of window for MIDAC gas cells. On the other hand, KBr has a lower yield strength (about 39x weaker) and is hygroscopic. When in contact with wet samples, it starts to fog over which degrades the IR throughput in the system. The big advantage of KBr is that it has a lower index of refraction (about 1.6x). The reflections off the ZnSe gas cell windows are most likely the cause of the DM in the Enthalpy data. Although we have taken extra steps to prevent this (wedge angle windows, anti-reflective coating), apparently there was still DM in the Enthalpy data.

Although DM is present, this is not a cause to reject all data collected. There are three basic arguments for this:

- Spectral regions of interest. Most of the spectral information in the *fingerprint* region (650-1500 cm⁻¹) does not receive any twice modulated ghost peaks. Yes, HCl and CH₂O receive the brunt of the problem, but this simply does not affect the data in the fingerprint. For the compounds that lie in the path of the DM, the addition of the DM noise simply causes the detection limits to be increased. This is the harshest effect on the data. Because the noise level is raised, the normal detection limit is raised.
- Interference spectra in the CLS method. A point raised in fax2 states that DM “adds spurious, or false, spectral lines which may be erroneously quantified as a target analyte.” It is clear from the faxes that the DM is most prevalent from the very high absorbance due to water vapor. Also the gas matrix had high humidity and the absorbance from the water is orders of magnitude stronger than most of the analytes. It is common practice when measuring high humidity samples to collect a water spectrum (either room air or by impinger method) and place this spectrum in the AutoQuant method. Even though water is not an analyte to measure, the CLS algorithm takes the peaks into account for interference calculations. Because the DM is present when taking the water calibration, the AutoQuant algorithm would not be prone to false positives!
- Measurement protocols. Enthalpy is well versed in EPA methodologies and protocols. Because they show matrix spiking and recoveries within EPA guidelines, this data alone validates the methods that they used. They also used a calibration transfer standard (CTS) as prescribed by the EPA. This exercise determines the effective optical pathlength of the gas cell and in effect will cancel out most optical phenomena. The combination of the CTS and analyte spiking shows that the FTIR can effectively measure gases in the stack environment they were testing.

Recommendations and Conclusions. After reviewing the faxes, we believe that although DM is present, it does not damage the data to where it should be thrown out. It does increase the detection limit of some analytes and imprint ghost peaks in the high frequency, but has minimal to no effect on the remainder of the spectrum. Also, the apparent electronic noise is probably just a misinterpretation of the CLS residual spectra.

MIDAC will be taking a harder closer look at the DM in our systems. Our existing data leads us to believe it is not a problem in all systems. For Enthalpy, the quickest remedy is to adjust the alignment or use KBr or KCl windows instead of ZnSe. In the long term, we will be evaluating window mounts that limit perpendicular reflections.

Please feel free to call or write with questions, comments, or concerns.

Regards,

Brian Wright
Sr. Applications Engineer

Gerald Auth
President

Attachment 4

Attachment 4

4ATP-AEB

Aug 07, 1996

Mr. Dwight R. Wylie, P.E.
Chief
Air Division Office of Pollution Control
Mississippi Department of Environmental Quality
P.O. Box 10385 Jackson, Mississippi 39289-0385

SUBJ: New Source Performance Standard Applicability Determination

Dear Mr. Wylie:

This letter is in response to your February 9, 1996, request for a determination regarding the applicability of 40 C.F.R. Part 60, Subpart Kb [Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced After July 23, 1984]. In your letter you requested information regarding the applicability of these regulations to asphalt storage tanks and to tanks used for storing oil driven off and collected from asphalt blowing stills at asphalt processing plants.

Applicability of Subpart Kb to either of these types of tanks would depend upon whether the material stored can be classified as a volatile organic liquid (VOL). According to the definitions in 40 C.F.R. 60.111b(k), a VOL is any organic liquid which can emit volatile organic compounds (VOCs) into the atmosphere, and VOC is defined in 40 C.F.R. 60.2 as any organic compound which participates in atmospheric photochemical reactions. Therefore, if a storage tank owner or operator can demonstrate that material stored in a tank does not emit VOCs to the atmosphere at the temperature at which the material is stored, the tank would not be subject to Subpart Kb.

With respect to the two types of tanks for which you requested a determination, it is more likely that an asphalt storage tank would be exempt from Subpart Kb than would one storing oil from an asphalt blowing still. Because asphalt is composed of heavy organic compounds, it may not emit VOCs to the atmosphere even if it is stored at an elevated temperature. According to your letter, oil collected from asphalt blowing stills is comparable to No. 6 fuel oil, and material of this type is light enough that it probably does emit VOCs to the atmosphere .

In order to qualify for an exemption from Subpart Kb, a source owner or operator must provide information on the temperature at which the material in the tank is stored and demonstrate that, at this temperature, no VOCs are emitted. Because the vapor pressure of asphalt is very low, an owner or operator of an asphalt storage tank would probably be subject only to recordkeeping requirements in 40 C.F.R. 60.116b if the tank does not qualify for an exemption from Subpart Kb. It would also be necessary to reevaluate the applicability of Subpart Kb if the owner or operator of a storage tank constructed, reconstructed, or modified after the applicability date for Subpart Kb (July 23, 1984)

obtains an exemption from Subpart Kb because the material stored in the tank does emit VOCs and later uses the tank for storing a more volatile material.

If you have any questions about the determination provided in this letter, please contact Mr. David McNeal of my staff at (404) 347-3555, extension 4158.

Sincerely yours,

Jewell A. Harper
Chief
Air Enforcement Branch
Air, Pesticides and Toxics
Management Division

Appendix A

1.0 Introduction

This appendix recommends an alternative approach to establishing emission limits for the thermal oxidizers controlling existing and new or reconstructed asphalt blowing stills and new or reconstructed loading racks, asphalt storage tanks, coating mixers, saturators, sealant applicators, and adhesive applicators. EPA has proposed emission limits based on a statistical analysis of data gathered during a sampling program conducted primarily during 1998 and 1999. ARMA and the EPA's Industrial Studies Branch, Emission Standards Division collaborated on the design of the program. It was funded by ARMA and conducted in accordance with state-of-the-art quality assurance and quality control protocols. ARMA recommends this alternative approach to establishing emission limits because the available data are not numerous enough to support the statistical analysis described in the preamble to the proposed rule.

ARMA's Proposal

If there are 30 or more sources in a source category, the MACT floor for existing sources must equal the average emissions limitations currently achieved by the best-performing 12 percent of sources in that source category. EPA has appropriately established thermal oxidizers operating at or above 1200°F as the MACT floor technology for existing blowing stills. However, in deriving emission limits associated with the MACT floor technology, EPA has used a statistical approach that is inapplicable to a small dataset. If the emission limits proposed by EPA are adopted, it is likely that many of the existing blowing stills controlled by thermal oxidizers operating at or above 1200°F (and that thus meet the statutory definition of MACT) would fail to comply with the standard. For the reasons described below, ARMA proposes that the combustion efficiency standard be established at 98% and that the THC destruction efficiency standard be established at 92%.

2.0 EPA's approach

2.1 Discussion of EPA's approach

EPA has used a statistical approach in proposing the total hydrocarbon (THC) reduction efficiency and the combustion efficiency emission limits for blowing stills. This discussion addresses both the numerical accuracy of the calculations and the appropriateness of the statistical method applied to the dataset. If the emission limits proposed by EPA are adopted, as many as half of the blowing stills that meet the statutory definition of MACT would fail to comply with the standard.

Section IV.F of the preamble to the asphalt roofing MACT proposal (p. 58622, col. 2-3) describes the approach used in establishing the emission limits for blowing stills.

Specifically, we calculated the average THC reduction efficiency achieved by each thermal oxidizer tested by averaging the THC destruction efficiency of the individual test runs performed. We then calculated an overall average THC destruction efficiency of 95.9 percent reduction for all five thermal oxidizers tested. To account for the variability in the performance of thermal oxidizers and ensure achievability, the standard

Appendix A of ARMA Comments

deviation (0.99) of the individual thermal oxidizer averages was subtracted from the overall average. This resulted in an emission limit for reduction of THC emissions of 95 percent.

An alternative expression of the standard for thermal oxidizers is the combustion efficiency standard. To establish the combustion efficiency that represents MACT, we used the outlet THC, CO and CO₂ concentration data from the same thermal oxidizers that were used to develop the percent reduction emission limit and the same statistical approach (i.e., determined overall combustion efficiency average and added (*sic*) one standard deviation). Using this approach, we established an average combustion efficiency of 99.6 percent.

The docket contains the original data used to develop the average and standard deviations for both THC destruction efficiency and combustion efficiency. Those data were contained in Table 4-1 of the July 27, 2001 memo from Amy Alexander and Mary Lalley of ERG to EPA's Rick Colyer and in Table 4 of a separate July 27, 2001 memo from Danny Greene to Rick Colyer. Docket Nos. II-B-16 and II-B-18. The relevant data are reproduced in Table A-1.

Table A-1 -- Data Used in EPA Analysis

Site	Process Equipment Controlled	Operating Temp °F	Run	Combustion Efficiency	THC Destruction Efficiency
Owens Corning Minneapolis, MN	Oxidized asphalt storage tanks and coater	1250	1	99.62	92.2
			2	99.37	97.7
			3	99.71	93.4
			4	99.64	95.4
			5	99.75	94.7
		Average		99.62	94.68
CertainTeed Oxford, NC	Blowing stills and oxidized asphalt storage tanks	1300	1	99.56	N/A
			2	99.04	N/A
			3	88.98	N/A
		Average		95.86	N/A
Celotex Fremont, CA	Coater, tanks, mixers, sealant and adhesive applicators	1400	1	99.73	96.7
			2	99.74	94.9
			3	99.75	94.3
		Average		99.74	95.3
Celotex Fremont, CA	Coater, tanks, mixers, sealant and adhesive applicators	1600	1	99.75	96.2
			2	99.78	96.1
			3	99.77	96.6
		Average		99.77	96.3
U. S. Intec Port Arthur, TX	Modified bitumen mixing and holding tanks	1400	1	N/A	91.6
			2	N/A	99.9
			3	N/A	99.8
		Average		N/A	97.1
Owens Corning Jessup, MD	Blowing stills, oxidized asphalt storage tanks, loading racks	1500	1	99.98	N/A
			2	99.96	N/A
			3	99.98	N/A
		Average		99.97	N/A

Average of Averages	98.99	95.8
Average of Averages excluding CertainTeed ¹	99.77	95.8
Sample Std Deviation (s) excluding CertainTeed	0.15	1.1
Population ² standard deviation (?) excluding CertainTeed	0.128	0.93
Std Deviation (s? or ??) excluding CertainTeed as calculated by EPA's contractor, ERG	0.13	0.99

¹ See Greene, p. 14.² Calculated only to determine if ERG determined the standard deviation using this approach.

2.2 Accuracy of the Calculations

ARMA has repeated the calculations performed by EPA's contractor (ERG) using the data shown in Table A-1. However, ARMA is unable to replicate ERG's calculation of the standard deviation for either the combustion efficiency data or the THC destruction efficiency data. ARMA used the following formula:

$$s = \sqrt{\frac{\sum (X_i)^2 - \frac{(\sum X_i)^2}{n}}{n - 1}}$$

Where:

s = the sample standard deviation,

X_i = the sample result for observation i ,

X_i^2 = the square of the individual sample result, and

n = the number of samples in the sample set

This is one of several equivalent versions of the formula appropriate for calculating the standard deviation of a *sample* of a population.³ To determine if ERG used the formula appropriate for calculating the standard deviation of an entire population, ARMA also calculated the *population* standard deviation, σ .

$$\sigma = \sqrt{\frac{\sum (X_i)^2 - \frac{(\sum X_i)^2}{N}}{N}}$$

Where:

s = the sample standard deviation,

X_i = the sample result for observation i ,

X_i^2 = the square of the individual sample result, and

n = the number of samples in the sample set

For combustion efficiency, the standard deviation calculated by EPA is the same as the *population* standard deviation. For THC destruction efficiency, the standard deviation presented in the July 27th memo to EPA is not the same as either the population standard deviation or the sample standard deviation. Apparently, there was a numerical error.

Statistics are used to represent populations and to make inferences about populations when data for the entire population are not available. In this case, a *sample* of 4 thermal oxidizers (one of them tested under two different temperature conditions) controlling a variety of production process types is being used to draw conclusions about a population of thermal oxidizers operating at or above 1200°F, the MACT floor technology. The *population* is all thermal oxidizers that operate at or above 1200°F. There are 69 such existing thermal oxidizers that control emissions from blowing stills. Accordingly s , the sample standard deviation, is the appropriate statistic rather than σ , the population standard deviation. The accurate values for s from this sample set are 0.15 and 1.1 for Combustion Efficiency and THC Destruction Efficiency respectively. However, as explained below, ARMA believes that the dataset contained in Table A-1 is not robust enough for statistical analysis.

³ See Business and Economic Statistics, Plane and Oppermann, 1981, p. 59.

2.3 EPA Statistical Conclusions

In the preamble, EPA explains that, “To account for the variability in the performance of thermal oxidizers and ensure achievability, the standard deviation (0.99) of the individual thermal oxidizer averages was subtracted from the overall average.” ARMA applauds EPA’s intent, but believes that the data are not robust enough to support the statistical analysis that has been applied. Due to the small size of the data set, subtracting only one standard deviation from the data is not adequate.

3.0 ARMA Comments on ERG Approach

3.1 Use of Representative Data.

In the preamble, EPA mentions that five thermal oxidizers were tested. This is accurate; however, data from the CertainTeed Oxford thermal oxidizer were not used because that thermal oxidizer experienced operating problems and the temperature was not stable during testing (see Greene, p.14). Testing at the following thermal oxidizers produced usable data: Owens Corning in Minneapolis, Celotex in Fremont (tested at 1400°F and 1600°F), U. S. Intec in Port Arthur, and Owens Corning in Jessup. However, there were no THC destruction efficiency data collected at the Jessup location and no combustion efficiency data collected at the Port Arthur location. As can be seen from Table A-1, the thermal oxidizers tested control a variety of emission sources. Only the Owens Corning Jessup plant included blowing still emissions. Additionally, the testing of the Celotex Fremont thermal oxidizer at 1600°F was not representative of normal operating conditions. The Fremont ICR notes that this abatement device typically operates at between 1300°F and 1500°F. The 1600°F testing was performed solely to determine whether there is any difference in destruction removal at the higher temperature. However, because that device also heats hot oil for the plant, it cannot be consistently operated at that temperature (Sanders, personal communication 1-09-02). Moreover, inclusion of two data points from a single plant in a database of only 4 samples (a database that is intended to represent the 69 thermal oxidizers on blowing stills operating at above 1200°F, see Alexander memo, Table 4-1) produces too heavy a representation of the Fremont abatement device in the sample population. Table A-2 contains the data that are appropriate for calculation of the average and standard deviation for thermal oxidizer operations. It is the same as Table A-1, without the CertainTeed data and the data for Fremont operating at 1600°F.

Table A-2 -- Data Used in ARMA Analysis

<u>Site</u>	<u>Operating Temp °F</u>	<u>Run</u>	<u>Combustion Efficiency</u>	<u>THC Destruction Efficiency</u>
Owens Corning Minneapolis, MN	1250	1	99.62	92.2
		2	99.37	97.7
		3	99.71	93.4
		4	99.64	95.4
		5	99.75	94.7
	Average		99.62	94.68
Celotex Fremont, CA	1400	1	99.73	96.7
		2	99.74	94.9
		3	99.75	94.3
	Average		99.74	95.3
U. S. Intec Port Arthur, TX	1400	1	N/A	91.6
		2	N/A	99.9
		3	N/A	99.8
	Average		N/A	97.1
Owens Corning Jessup, MD	1500	1	99.98	N/A
		2	99.96	N/A
		3	99.98	N/A
	Average		99.97	N/A

\bar{X}	Average of Averages	99.78	95.7
s	Std Deviation of the sample set	0.18	1.3
n	the number of samples	3	3
ν	the degrees of freedom ($n - 1$)	2	2
$\bar{X} - s$	Emission limit calculated using EPA's proposed approach	99.6	94.4
Probability that the true population mean is below X-s.		11.28%	11.28%

3.2 ARMA Proposal - Combustion Efficiency

Given that the dataset is small, ARMA proposes that EPA establish 98% as the Combustion Efficiency standard. This value is selected from EPA's Air Pollution Technology Fact Sheet on Thermal Incinerators. "Typical thermal incinerator design efficiencies range from 98 to 99.99% and above, depending on system requirements and characteristics of the contaminated stream⁴." EPA has met its duty to establish the MACT floor as the best-performing 12 percent of sources. It should not further require that the existing control devices be operated to meet efficiency standards for which they were not designed (i.e. a control efficiency of 99.6%). If the MACT emission standard were set at 99.6%, some sources controlled by MACT-floor compliant thermal oxidizers would have to be replaced by control devices designed to meet the new standard. This outcome is unnecessarily burdensome, represents little reduction in HAP emissions and is inconsistent with EPA's statutory mandate to establish limitations at the levels currently achieved by the best-performing 12 percent of sources in that source category. Thus, to account for variability among facilities, processes, streams, and test conditions, EPA should set the destruction efficiency at 98%, the low end of the 98 to 99.99% range reported by EPA in the EPA fact sheet cited in note 4.

3.3 ARMA Proposal - THC Destruction Efficiency

There are few available data on THC destruction efficiency. A search of the worldwide web for "THC destruction efficiency" yielded only the current asphalt roofing proposal, posted on EPA's website. Accordingly, there is no comparable source of information on typical performance of thermal oxidizers with respect to THC destruction efficiency. ARMA proposes that the THC destruction efficiency limit be established at 92%. This figure was arrived at in two ways. First, a visual review of the data show that the lowest hourly THC destruction efficiency observed was 92.2% (see table A-1). Because the emission sources will be required to continuously comply with the emission limits, establishing a limit higher than 92% almost certainly would require replacement of some MACT-floor compliant control devices. The 92% figure is also supported by the statistical analysis presented below. This analysis is appropriate for a small dataset.

3.3.1 Statistical Treatment of the Data.

Table A-2 shows the appropriate data for calculation of statistics on thermal oxidizer performance. There are three data points for THC Destruction Efficiency, i.e. $n = 3$. For small sample sets which are assumed to be normally distributed, the t -Distribution is used to make statistical inferences. The shape of the t -distribution approaches that of the normal distribution as n approaches 30, but for smaller values of n , the distribution is quite different; the "bell shape" is much flatter. To calculate the confidence interval for a small sample, the following equation is used⁵:

$$\text{Confidence interval for a small sample} = \bar{X} \pm t \frac{s}{\sqrt{n}}$$

⁴ EPA-CICA Fact Sheet, Thermal Incinerator, p. 1 (attached). Undated, found at <http://www.epa.gov/ttnatc1/dir1/fthermal.pdf> on January 10, 2002.

⁵ See Business and Economic Statistics, Plane and Oppermann, 1981, p. 189.

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The confidence interval is the interval around the sample mean, \bar{X} , associated with a probability that the population mean, μ , falls between the boundaries of the confidence interval.

Where:

- \bar{X} = the mean of the samples in the dataset
- t = is determined from the t-table for a given number of degrees of freedom, ν and a given probability (the right tail area under the t -Density Function)
- s = the sample standard deviation
- n = the number of samples in the dataset. (In this case, $n = 3$.)
- ν = the degrees of freedom or $n-1$. (In this case, $\nu = 2$.)

The right tail area under the t -Density function represents the probability that the mean of the population (not any individual data point) falls outside the confidence interval.

EPA has determined that a thermal oxidizer operating at or above 1200°F is the basis for the MACT floor for control of organic HAP from blowing stills at existing, new and reconstructed affected sources. Solving for t , we can determine the probability that the mean of the population μ is outside the boundaries of one standard deviation.

The confidence interval for a small sample = $\bar{X} \pm t \frac{s}{\sqrt{n}}$. For THC destruction

efficiency, $\bar{X} = 95.7$, $s = 1.3$, $n=3$ and $\nu=2$.

So if the emission limit were set at $\bar{X} - s = 94.4$;

$94.4 = \bar{X} - t \frac{s}{\sqrt{n}}$, or $s (1.3)$ would equal $t \frac{s}{\sqrt{n}}$, or $t = 1.7320$. Looking up the

right tailed area for $t = 1.7320$ in the t-Distribution table for $\nu = 2$ and extrapolating between the values for 1.7 and 1.8 yields a right-tail area of 0.1128 or 11.28%. The statistical inference drawn is that 11.28% of the time, the mean of the population, μ , represented by the sample data set would be expected to be below $\bar{X} - s$ or below 94.4%. This is a statistical inference about the *mean* of the population, μ . In a normally distributed data set, half of the individual data points (50%) are below the mean, 15.9% are more than one standard deviation below the mean, 2.3% are more than two standard deviations below the mean and 1.3% are more than 3 standard deviations below the mean. The impact using $\bar{X} - s$ to establish the emission limits can be explained as follows. There is an 11.28% probability that the true mean of the population represented by the dataset shown in Table A-2 is less than or equal to $\bar{X} - s = 94.4$ % for THC destruction efficiency. If the population mean is actually 94.4%, out of the population of 69 blowing stills, only 50% or 34 of the stills would comply with the standard. The remaining 50%, though controlled by the MACT floor technology (thermal oxidizers operating at or above 1200°F), would not meet the emission standards. ARMA believes that this is not consistent with the EPA's stated intent "to account for the variability in the performance of thermal oxidizers and ensure achievability."

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Accordingly, ARMA recommends that the right tailed area under the t-Density function be set at 2% or lower. For a right tailed area of 2% or 0.02, the t-table shows that t for $\nu = 2$ degrees of freedom is 4.85.

For THC destruction efficiency, $\bar{X} = 94.4$, $s = 1.3$, $t = 4.85$, and $n = 3$, so using the equation for the confidence interval $= \bar{X} \pm t \frac{s}{\sqrt{n}}$, the lower limit of the confidence interval is $95.7 - 4.85 \frac{1.3}{\sqrt{3}} = 92.06\%$.

If 92% is established as the emission limit, and the actual mean of the population is 94.4% (again, there is an 11.28% predicted probability that the actual mean is 94.4% or less) the probability that any particular thermal oxidizer will fail the emission standard can be predicted if it is assumed that the population standard deviation, μ , is equal to 1.3 the sample standard deviation, s . The probability that any individual thermal oxidizer will violate the emission standard can be calculated using the following equation:⁶

$$Z = \frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} = \frac{95.7 - 94.4}{1.3} = 1.0$$

Where:

- μ = the true mean of the population
- \bar{X} = the mean of the samples in the dataset
- Z = the standard normal random variable.

From the Standard Normal Density Function, when $Z = 1.0$, the right-tail area under the function is 0.1587. That means that 15.87% of the thermal oxidizers in the dataset (or 11 of the 69) thermal oxidizers controlling blowing stills would be found to violate the standard although they had the MACT technology in place. While this outcome is far more reasonable than the previous scenario (50%), it would still be a hardship to the companies operating the thermal oxidizers affected.

The modifications suggested in the emission limits are consistent with EPA's mandate to establish a MACT floor equal to the average emissions limitations currently achieved by the best-performing 12 percent of sources in that source category and with EPA's intent "to account for the variability in the performance of thermal oxidizers and ensure achievability. See p. 58622 of asphalt roofing MACT proposal, at col. 3.

4.0 Conclusions

In the case of existing blowing stills, there are insufficient data to conduct statistical analysis of the type conducted by EPA's contractor. ARMA believes that the combustion efficiency standard for existing sources be established at 98% and that the THC destruction efficiency standard be established at 92%. These values are based on typical efficiencies for thermal oxidizers, a visual analysis of the data and statistical analysis appropriate to the small data set. Adopting these values will make the emission limits

⁶ See Business and Economic Statistics, Plane and Oppermann, 1981, p. 139.

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consistent with EPA's statutory mandate and with EPA's intent "to account for the variability in the performance of thermal oxidizers and ensure achievability."

Appendix A of ARMA Comments

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Air Pollution Technology Fact Sheet



1. *Name of Technology:* Thermal Incinerator

This type of incinerator is also referred to as a direct flame incinerator, thermal oxidizer, or afterburner. However, the term afterburner is generally appropriate only to describe a thermal oxidizer used to control gases coming from a process where combustion is incomplete.

2. *Type of Technology:* Destruction by thermal oxidation

3. *Applicable Pollutants:* Primarily volatile organic compounds (VOC). Some particulate matter (PM), commonly composed as soot (particles formed as a result of incomplete combustion of hydrocarbons (HC), coke, or carbon residue) will also be destroyed in various degrees.

4. *Achievable Emission Limits/Reductions:*

VOC destruction efficiency depends upon design criteria (i.e., chamber temperature, residence time, inlet VOC concentration, compound type, and degree of mixing) (EPA, 1992). Typical thermal incinerator design efficiencies range from 98 to 99.99% and above, depending on system requirements and characteristics of the contaminated stream (EPA, 1992; EPA, 1996a). The typical design conditions needed to meet $\geq 98\%$ control or a 20 parts per million by volume (ppmv) compound exit concentration are: 870°C (1600°F) combustion temperature, 0.75 second residence time, and proper mixing. For halogenated VOC streams, 1100°C (2000°F) combustion temperature, 1.0 second residence time, and use of an acid gas scrubber on the outlet is recommended (EPA, 1992).

For vent streams with VOC concentration below approximately 2000 ppmv, reaction rates decrease, maximum VOC destruction efficiency decreases, and an incinerator outlet VOC concentration of 20 ppmv, or lower may be achieved (EPA, 1992).

Controlled emissions and/or efficiency test data for PM in incinerators are not generally available in the literature. Emission factors for PM in phthalic anhydride processes with incinerators are available, however. The PM control efficiencies for these processes were found to vary from 79 to 96% (EPA, 1998). In EPA's 1990 National Inventory, incinerators used as control devices for PM were reported as achieving 25 to 99% control efficiency of particulate matter 10 microns or less in aerodynamic diameter (PM_{10}) at point source facilities (EPA, 1998). Table 1 presents a breakdown of the PM_{10} control efficiency ranges by industry for recuperative incinerators (EPA, 1996b). The VOC control efficiency reported for these devices ranged from 0 to 99.9%. These ranges of control efficiencies are large because they include facilities that do not have VOC emissions and control only PM, as well as facilities which have low PM emissions

and are primarily concerned with controlling VOC (EPA, 1998).

Table 1. Thermal Incinerator PM₁₀ Destruction Efficiencies by Industry (EPA, 1996b)

Industry/Types of Sources	PM ₁₀ Control Efficiency (%)
Petroleum and Coal Products asphalt roofing processes (blowing, felt saturation); mineral calcining; petroleum refinery processes (asphalt blowing, catalytic cracking, coke calcining, sludge converter); sulfur manufacturing	25 - 99.9
Chemical and Allied Products carbon black manufacturing (mfg); charcoal mfg; liquid waste disposal; miscellaneous chemical mfg processes; pesticide mfg; phthalic anhydride mfg (xylene oxidation); plastics/synthetic organic fiber mfg; solid waste incineration (industrial)	50 - 99.9
Primary Metals Industries by-product coke processes (coal unloading, oven charging and pushing, quenching); gray iron cupola and other miscellaneous processes; secondary aluminum processes (burning/drying, smelting furnace); secondary copper processes (scrap drying, scrap cupola, and miscellaneous processes); steel foundry miscellaneous processes; surface coating oven	70 - 99.9
Electronic and Other Electric Equipment chemical mfg miscellaneous processes; electrical equipment bake furnace; fixed roof tank; mineral production miscellaneous processes; secondary aluminum roll/draw extruding; solid waste incineration (industrial)	70 - 99.9
Electric, Gas, and Sanitary Services internal combustion engines; solid waste incineration (industrial, commercial/institutional)	90 - 98
Stone, Clay, and Glass Products barium processing kiln; coal cleaning thermal dryer; fabricated plastics machinery; wool fiberglass mfg	50 - 95

Industry/Types of Sources	PM₁₀ Control Efficiency (%)
Food and Kindred Products charcoal processing, miscellaneous; corn processing, miscellaneous, fugitive processing, miscellaneous; soybean processing, miscellaneous	70 - 98
Mining asphalt concrete rotary dryer; organic chemical air oxidation units, sulfur production	70 - 99.6
National Security and International Affairs solid waste incineration (commercial/institutional and municipal)	70
Textile Mill Products plastics/synthetic organic fiber (miscellaneous processes)	88 - 95
Industrial Machinery and Equipment secondary aluminum processes (burning/drying, smelt furnace)	88 -98
Lumber and Wood Products solid waste incineration (industrial)	70
Transportation Equipment solid waste incineration (industrial)	70 - 95

5. *Applicable Source Type:* Point

6. *Typical Industrial Applications:*

Thermal incinerators can be used to reduce emissions from almost all VOC sources, including reactor vents, distillation vents, solvent operations, and operations performed in ovens, dryers, and kilns. They can handle minor fluctuations in flow, however, excess fluctuations require the use of a flare (EPA, 1992). Their fuel consumption is high, so thermal units are best suited for smaller process applications with moderate-to-high VOC loadings.

Incinerators are used to control VOC from a wide variety of industrial processes, including, but not limited to the following (EPA, 1992):

- Storing and loading/unloading of petroleum products and other volatile organic liquids;
- Vessel cleaning (rail tank cars and tank trucks, barges);
- Process vents in the synthetic organic chemical manufacturing industry (SOCMI);
- Paint manufacturing;

- Rubber products and polymer manufacturing;
- Plywood manufacturing;
- Surface coating operations:
 - Appliances, magnetic wire, automobiles, cans, metal coils, paper, film and foil, pressure sensitive tapes and labels, magnetic tape, fabric coating and printing, metal furniture, wood furniture, flatwood paneling, aircraft, miscellaneous metal products;
- Flexible vinyl and urethane coating;
- Graphic arts industry; and
- Hazardous waste treatment storage, and disposal facilities (TSDFs).

7. *Emission Stream Characteristics:*

- a. Air Flow:* Typical gas flow rates for thermal incinerators are 0.24 to 24 standard cubic meters per second (sm³/sec) (500 to 50,000 standard cubic feet per minute (scfm)) (EPA, 1996a).
- b. Temperature:* Most incinerators operate at higher temperatures than the ignition temperature, which is a minimum temperature. Thermal destruction of most organic compounds occurs between 590°C and 650°C (1100°F and 1200°F). Most hazardous waste incinerators are operated at 980°C to 1200°C (1800°F to 2200°F) to ensure nearly complete destruction of the organics in the waste (AWMA, 1992).
- a. Pollutant Loading:* Thermal incinerators can be used over a fairly wide range of organic vapor concentrations. For safety considerations, the concentration of the organics in the waste gas must be substantially below the lower flammable level (lower explosive limit, or LEL) of the specific compound being controlled. As a rule, a safety factor of four (i.e., 25% of the LEL) is used (EPA, 1991, AWMA, 1992). The waste gas may be diluted with ambient air, if necessary, to lower the concentration. Considering economic factors, thermal incinerators perform best at inlet concentrations of around 1500 to 3000 ppmv, because the heat of combustion of hydrocarbon gases is sufficient to sustain the high temperatures required without addition of expensive auxiliary fuel (EPA, 1995).
- d. Other Considerations:* Incinerators are not generally recommended for controlling gases containing halogen- or sulfur-containing compounds, because of the formation of hydrogen chloride, hydrogen fluoride gas, sulfur dioxide, and other highly corrosive acid gases. It may be necessary to install a post-oxidation acid gas treatment system in such cases, depending on the outlet concentration. This would likely make incineration an uneconomical option. (EPA, 1996a). Thermal incinerators are also not generally cost-effective for low-concentration, high-flow organic vapor streams (EPA, 1995).

8. *Emission Stream Pretreatment Requirements:*

Typically, no pretreatment is required, however, in some cases, a concentrator (e.g., carbon

or zeolite adsorption) may be used to reduce the total gas volume to be treated by the more expensive incinerator.

9. Cost Information:

The following are cost ranges (expressed in third quarter 1995 dollars) for packaged thermal incinerators of conventional design under typical operating conditions, developed using EPA cost-estimating spreadsheets (EPA, 1996a) and referenced to the volumetric flow rate of the waste stream treated. The costs do not include costs for a post-oxidation acid gas treatment system. Costs can be substantially higher than in the ranges shown when used for low to moderate VOC concentration streams (less than around 1000 to 1500 ppmv). As a rule, smaller units controlling a low concentration waste stream will be much more expensive (per unit volumetric flow rate) than a large unit cleaning a high pollutant load flow. Operating and Maintenance (O & M) Costs, Annualized Cost, and Cost Effectiveness are dominated by the cost of supplemental fuel required.

- a. Capital Cost:** \$10,000 to \$210,000 per sm^3/sec (\$5 to \$100 per scfm)
- b. O & M Cost:** \$85,000 to \$160,000 per sm^3/sec (\$40 to \$75 per scfm), annually
- c. Annualized Cost:** \$85,000 to \$210,000 per sm^3/sec (\$40 to \$100 per scfm), annually
- d. Cost Effectiveness:** \$440 to \$3,600 per metric ton (\$400 to \$3,300 per short ton), annualized cost per ton per year of pollutant controlled

10. Theory of Operation:

Incineration, or thermal oxidation is the process of oxidizing combustible materials by raising the temperature of the material above its auto-ignition point in the presence of oxygen, and maintaining it at high temperature for sufficient time to complete combustion to carbon dioxide and water. Time, temperature, turbulence (for mixing), and the availability of oxygen all affect the rate and efficiency of the combustion process. These factors provide the basic design parameters for VOC oxidation systems (ICAC, 1999).

A straight thermal incinerator is comprised of a combustion chamber and does not include any heat recovery of exhaust air by a heat exchanger (this type of incinerator is referred to as a recuperative incinerator).

The heart of the thermal incinerator is a nozzle-stabilized flame maintained by a combination of auxiliary fuel, waste gas compounds, and supplemental air added when necessary. Upon passing through the flame, the waste gas is heated from its preheated inlet temperature to its ignition temperature. The ignition temperature varies for different compounds and is usually determined empirically. It is the temperature at which the combustion reaction rate exceeds the rate of heat losses, thereby raising the temperature of the gases to some higher value. Thus, any organic/air mixture will ignite if its temperature is raised to a sufficiently high level

(EPA, 1996a).

The required level of VOC control of the waste gas that must be achieved within the time that it spends in the thermal combustion chamber dictates the reactor temperature. The shorter the residence time, the higher the reactor temperature must be. The nominal residence time of the reacting waste gas in the combustion chamber is defined as the combustion chamber volume divided by the volumetric flow rate of the gas. Most thermal units are designed to provide no more than 1 second of residence time to the waste gas with typical temperatures of 650 to 1100°C (1200 to 2000°F). Once the unit is designed and built, the residence time is not easily changed, so that the required reaction temperature becomes a function of the particular gaseous species and the desired level of control (EPA, 1996a).

Studies based on actual field test data, show that commercial incinerators should generally be run at 870°C (1600°F) with a nominal residence time of 0.75 seconds to ensure 98% destruction of non-halogenated organics (EPA, 1992).

11. Advantages/Pros:

Incinerators are one of the most positive and proven methods for destroying VOC, with efficiencies up to 99.9999% possible. Thermal incinerators are often the best choice when high efficiencies are needed and the waste gas is above 20% of the LEL.

12. Disadvantages/Cons:

Thermal incinerator operating costs are relatively high due to supplemental fuel costs.

Thermal incinerators are not well suited to streams with highly variable flow because of the reduced residence time and poor mixing during increased flow conditions which decreases the completeness of combustion. This causes the combustion chamber temperature to fall, thus decreasing the destruction efficiency (EPA, 1991).

Incinerators, in general, are not recommended for controlling gases containing halogen- or sulfur-containing compounds because of the formation of highly corrosive acid gases. It may be necessary to install a post-oxidation acid gas treatment system in such cases, depending on the outlet concentration (EPA, 1996a). Thermal incinerators are also not generally cost-effective for low-concentration, high-flow organic vapor streams (EPA, 1995).

13. Other Considerations:

Thermal incinerators are not usually as economical, on an annualized basis, as recuperative or regenerative incinerators because they do not recover waste heat energy from the exhaust gases. This heat can be used to preheat incoming air, thus reducing the amount of supplemental fuel required. If there is additional heat energy available, it can be used for other process heating needs.

14. References:

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Appendix B

Appendix B of ARMA MACT Comments

This appendix provides a calculation of the cost per ton of HAP removed for a tank with a true vapor pressure of 10.3 kilopascals or “kPa” (1.5 psia). Such a tank would have total HAP emissions of less than 0.1 tons per year. This emission estimate is based on data provided in an article by David C. Trumbore published in the Winter 1999 Issue of *Environmental Progress*, “Estimates of Air Emissions from Asphalt Storage Tanks and Truck Loading” (copy attached). That article derives an equation relating pollutant emissions to tank vapor pressure. See also the emission factors provided to EPA in ARMA’s February 2, 2001 submittal, Docket No. II-D-30.

If EPA’s applicability provisions for asphalt storage tanks and loading racks are adopted as proposed, facilities might effectively be forced to install a dedicated thermal oxidizer for tanks and loading racks that are located far from roofing lines (and the associated control equipment) at an asphalt roofing manufacturing plant. Logistical difficulties and high costs could make it too difficult or expensive to duct the air stream from the tanks to the thermal oxidizer that is used to control the rest of the line or lines. In this case, a stand-alone thermal oxidizer would be required for the tanks.

ARMA estimates that the capital cost to construct and install a thermal oxidizer to control the HAP emissions (in an air stream of less than 1000 cfm) would be approximately \$100,000. Amortizing the capital costs at a 7% interest rate and assuming that the equipment has a 10-year life, the annualized cost of capital is \$14,240. Operating costs (including power, natural gas, labor and maintenance) would vary be about \$30,000/year.¹ Thus, the annual operating costs would be \$44,240/year to treat less than 0.1 tons per year of HAP. This results in a cost of \$442,400/ton of HAP - for very few tons of HAPs.

EPA has discretion not to regulate units and processes with *de minimis* or low HAP emissions; the agency regularly uses its discretion in this way in MACT rulemakings. Emissions from tanks and loading racks with low true vapor pressure are *de minimis*; costs to control these emissions are high. Emissions from tanks and loading racks with a true vapor below 10.2 kPa therefore should not be regulated under the final MACT rules.

¹ Note that these cost estimates are consistent with EPA’s findings in the agency’s “Air Pollution Control Technology Fact Sheet” for thermal incinerators attached to Appendix A of these comments. That Fact Sheet notes the high cost of building such smaller thermal oxidizers with reduced VOC concentration streams (as would be found with most storage tanks and loading racks): “Costs can be substantially higher than in the ranges shown when used for low to moderate VOC concentration streams (less than around 1000 to 1500 ppmv). As a rule, smaller units controlling a slow concentration waste stream will be much more expensive (per unit volumetric flow rate) than a large unit cleaning a high pollutant load flow.” Fact Sheet at p. 5.

Estimates of Air Emissions from Asphalt Storage Tanks and Truck Loading

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Title V of the 1990 Clean Air Act requires the accurate estimation of emissions from all U.S. manufacturing processes, and places the burden of proof for that estimate on the process owner. This paper is published as a tool to assist in the estimation of air emissions from hot asphalt storage tanks and asphalt truck loading operations. Data are presented on asphalt vapor pressure, vapor molecular weight, and the emission split between volatile organic compounds and particulate emissions that can be used with AP-42 calculation techniques to estimate air emissions from asphalt storage tanks and truck loading operations. Since current AP-42 techniques are not valid in asphalt tanks with active fume removal, a different technique for estimation of air emissions in those tanks, based on direct measurement of vapor space combustible gas content, is proposed. Likewise, since AP-42 does not address carbon monoxide or hydrogen sulfide emissions that are known to be present in asphalt operations, this paper proposes techniques for estimation of those emissions. Finally, data are presented on the effectiveness of fiber bed filters in reducing air emissions in asphalt operations.

INTRODUCTION

The use of asphalt is prevalent throughout recorded history. It is produced in refinery distillation towers and solvent extraction units. Asphalt is modified by several means: reacting with oxygen in blowing operations to produce roofing asphalts, emulsifying to produce an aqueous liquid at ambient temperature, blending with solvents to make asphalt cutback, or blending or even reacting with polymers to make polymer modified asphalt. In all these cases the asphalt is stored in tanks, usually fixed roof tanks, and is loaded into trucks to ship to customers.

Title V of the 1990 Clean Air Act required the accurate estimation of emissions from all U.S. manufacturing processes, and placed the burden of proof for that estimate on the process owner. In response to Title V, Owens Corning analyzed options for estimating emissions from

asphalt tanks and loading operations and this paper is the result of that study. In particular, attempts have been made to develop data to be used with existing calculation methods to estimate air emissions in asphalt operations, to develop calculation schemes that work when existing methods cannot be used, and to expand the number of pollutants estimated. The techniques described in this paper have been used by Owens Corning to estimate asphalt emissions from their asphalt plants for many Title V permit applications.

Owens Corning also evaluated appropriate emission factors for the asphalt blowing process and that analysis has been published [1].

The Emission Factor and Inventory Group in the U. S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards develops and maintains a database of emission factors and a series of calculation methods for estimating air emissions from manufacturing processes. These emission factors are published in a series known as AP-42 [2]. One technique published in AP-42 calculates hydrocarbon emissions from a fixed roof tank storing petroleum products [3], and another calculates emissions for loading trucks with petroleum products [4]. These techniques require data on asphalt vapor pressure and the molecular weight of the asphalt vapor. The calculations result in an estimate of the amount of hydrocarbons emitted from the process. To complete the emission estimate, these hydrocarbons need to be split into particulate emissions (PM) and volatile organic compounds (VOC), and any control device collection or destruction efficiencies need to be applied.

In the AP-42 calculation of emissions from fixed roof tanks it is assumed that the motive force pushing vapor out of the tank comes from either the pumping of liquid into the tank or the expansion of tank contents due to temperature changes. For tanks with an active ventilation system this assumption is invalid and a different method of emission estimation is required. This is especially true if an air sweep is used to control the vapor space composition to

prevent explosive conditions [5,6]. A technique to estimate emissions from these actively controlled tanks is described in the section of this paper on non AP-42 estimates.

AP-42 EMISSION ESTIMATING TECHNIQUES FOR ASPHALT EQUIPMENT

Passive vented hot asphalt tanks: AP-42 for fixed roof petroleum tanks can be used to calculate total hydrocarbon emissions from asphalt and oil tanks that are passively vented to the atmosphere. This AP-42 calculation, simply stated, determines the amount of hydrocarbon in the tank vapor space from the vapor pressure of the material in the tank at the liquid surface temperature, and then calculates the amount of vapor forced out of the tank due to liquid being actively pumped into the tank (working losses), or due to thermal expansion or contraction of tank contents driven by ambient temperature changes (breathing losses). The result is an actual weight of hydrocarbon emissions in a specified time period. A detailed description of the tank calculations is available from the EPA web site [3]. The AP-42 calculation requires a vapor pressure versus temperature curve for the asphalt, and also estimates of the vapor phase molecular weight and partition of hydrocarbons into VOC and particulate, in addition to process data like asphalt throughput, temperature, and tank level. If the tank passively breathes through a control device, then the appropriate control efficiency is applied to the VOC and particulate emissions calculated from AP-42.

Hot Asphalt Loading: The AP-42 calculation for hydrocarbon emissions from truck or rail tank car loading of asphalt is done by estimating the amount of evaporation during the loading process. The estimate takes into account the turbulence and vapor liquid contact induced by the method of loading, i.e. submerged versus splash loading. The calculation result is an emission related to the number of tons of material loaded into the truck. Vapor pressure versus temperature curves, temperature of loading, and throughputs are key variables in this calculation. Again, the hydrocarbon emission resulting from this calculation needs to be split into particulates and VOCs and control device collection and destruction efficiencies need to be applied. A detailed description of the loading calculations is available from the EPA web site [4].

DATA NEEDED FOR APPLICATION OF AP-42 TO ASPHALT EQUIPMENT

Vapor Pressure: Information on asphalt vapor pressure as a function of temperature is not readily available in the literature and its measurement is not common. However, these data are essential to use AP-42 calculations for estimating asphalt tank and loading emissions. Asphalts from different crude oil sources and from different processes will differ in composition and vapor pressure. In the extreme, every residual material used in asphalt processing would need to be measured for vapor pressure at multiple temperatures. This would entail a prohibitive amount of testing for minimal gain in accuracy of emission estimates. To provide a cost effective solution to this problem for its emission calculations, Owens Corning has

characterized the vapor pressure of three basic classes of asphalt materials, chosen by their processing history. An estimate of the vapor pressure of each asphalt class was made by measuring asphalts from multiple crude oil sources in each class and using the average vapor pressure at each temperature in a regression to generate one vapor pressure equation for that class. The three classes of asphalt chosen for this analysis follow.

- Flux asphalts, or vacuum tower bottoms that can be used in the asphalt blowing process to make specification roofing asphalts. These materials generally have a higher vapor pressure than paving asphalts.
- Paving asphalts, or vacuum tower bottoms that meet paving specifications.
- Oxidized asphalt, or vacuum tower bottoms that have been reacted with oxygen in the asphalt blowing process to increase their softening point and viscosity. Typical softening points are greater than 190°F (88°C). These materials are also called air blown asphalts and are used extensively in the roofing industry. They generally have lower vapor pressure than the other two classes.

Vapor pressure measurements described in this paper were done by the Phoenix Chemical Lab in Chicago using the Isotenoscope (ASTM D2879).

To facilitate computer calculations it is desirable to develop an equation that accurately describes the relationship of vapor pressure and temperature. Thermodynamic treatment of the dependence of vapor pressure on temperature has led to the Clausius modification of the Clapeyron equation [7]:

Clausius Clapeyron Treatment of Vapor Pressure Data

$$\ln P = a + b/T$$

Where: P is the equilibrium vapor pressure of the liquid in question,
a & b are constants, and
T is the absolute temperature of the liquid in question.
Values of a & b depend on the choice of pressure and temperature units.

Table 1 and Figure 1 give an example of the agreement of this equation with vapor pressure data for oxidized asphalts from 13 sources around the country. In Figure 1, vapor pressure of each asphalt is plotted versus temperature to show the differences between asphalts, and the good agreement of each individual asphalt's data to the Clausius Clapeyron relationship. The correlation coefficients in Table 1 indicate that the agreement of this equation to all individual asphalt vapor pressure versus temperature data is excellent, with correlation coefficients for the individual asphalts greater than 0.9999. The agreement is also excellent for the individual asphalts making up the other two asphalt classes. Table 1 also presents the methodology to choose constants to use with the

Table 1. Vapor Pressure Data for Oxidized Asphalts

Asphalt	Temperature (°F) ¹					All Data in mm Hg ²					r value ³
	200	250	300	350	400	450	500	550	575	600	
Plant A			0.39	2	7.9	26	77	225		550	-0.999922929
Plant C		0.42	2	7.9	26	71	180	460	670		-0.999934558
Plant H		0.43	2	7.7	25	68	165	410	590		-0.999939281
Plant I		0.44	1.9	7.2	22	59	140	340		680	-0.999945804
Plant K	0.43	1.7	6.1	18.5	50	115	205	510	680		-0.999660554
Plant M	0.28	1.2	4.6	15	41	97	210	460	640		-0.999948167
Plant N	0.19	0.88	3.5	12	34	85	190	430	590		-0.999965421
Plant P	0.46	1.8	6	17.5	44	96	195	410		710	-0.999948079
Plant O		0.11	0.47	1.7	5.2	13.2	34	74		142	-0.999916578
Plant J		0.16	0.64	2.2	6.2	14.8	36	72		135	-0.999838114
Plant S	0.28	1.05	3.3	9.4	23	50	105	200		350	-0.999986213
Plant S				0.28	1	3.2	10	25		58	-0.999875798
Plant X		0.1	0.4	1.5	4.7	12.5	33	75		152	-0.999930649
Class Standard	0.22	0.91	3.2	9.5	24.9	58.8	127	254	351	477	
Average Vp	0.33	0.75	2.6	7.9	22.3	54.7	122	284	634	347	-0.994026635

13459 b in Clausius Clapeyron curve for average vapor pressure data

18.86 a in Clausius Clapeyron curve for average vapor pressure data

1. $1^{\circ}\text{C} = (^{\circ}\text{F} - 32) * 5/9$
2. $1\text{ Pa} = 0.0075\text{ mm Hg}$
3. the r value is for the fit of the vapor pressure data to the Clausius Clapeyron Equation

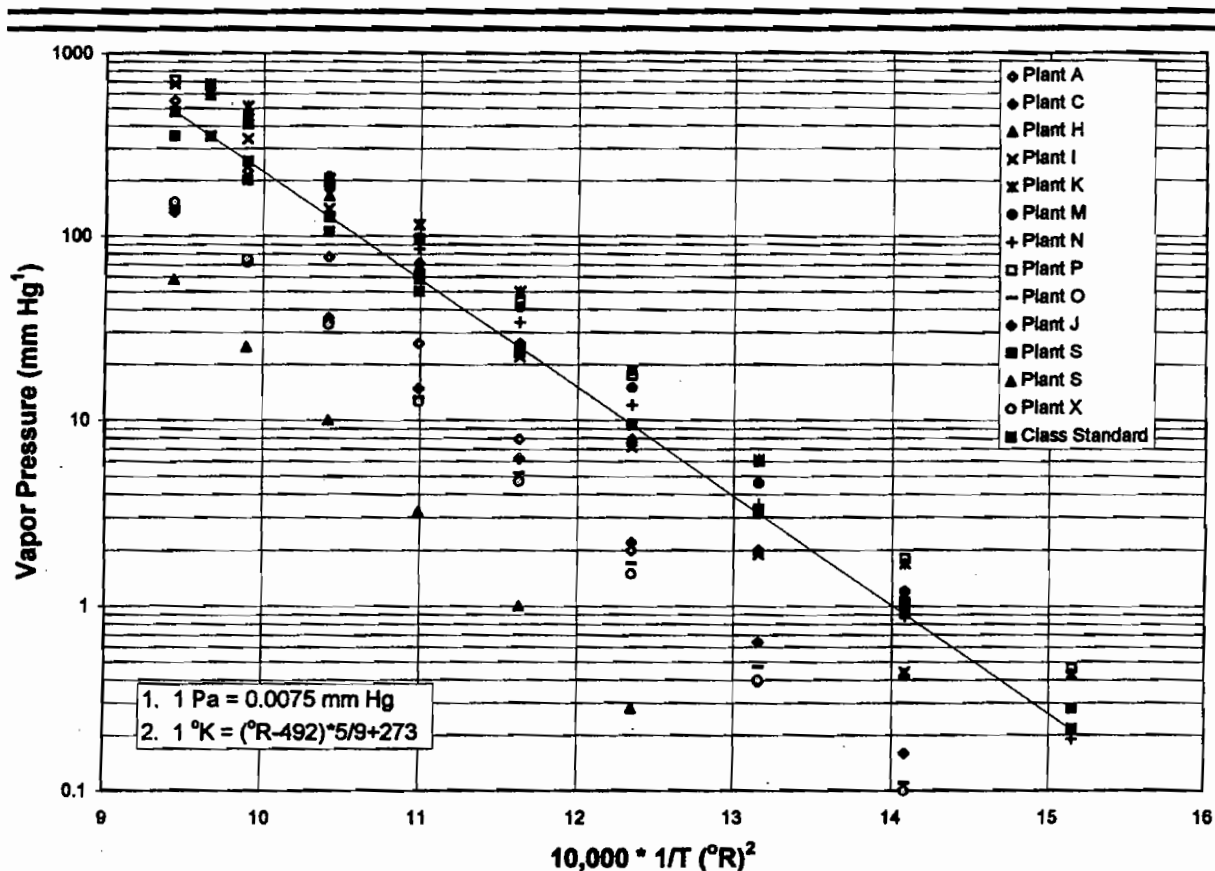


FIGURE 1. Oxidized Asphalt Vapor Pressure Data in Clausius Clapeyron Format

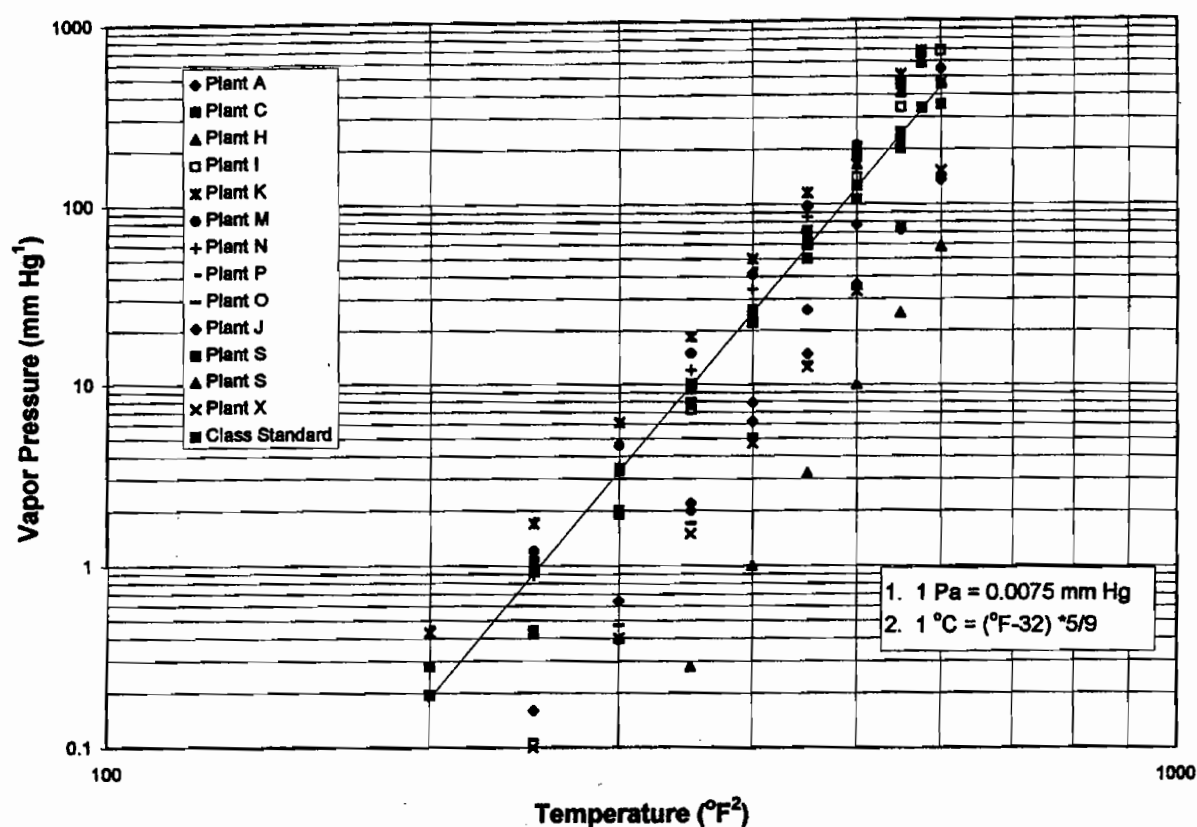


FIGURE 2. Oxidized Asphalt Vapor Pressure Data in Double Log Format

Clausius Clapeyron equation to calculate a representative vapor pressure at any temperature for the class of oxidized asphalts. Essentially the technique consists of averaging the vapor pressures of the 13 asphalts at each temperature and then using those averages to curve fit the data to the desired equation. This gives higher values and is more conservative than averaging the vapor pressures after the log transformation is made. The standard curve is developed by using this regression equation to calculate vapor pressures at different temperatures, and for the oxidized class that data is indicated in Table 1 and also by the straight line in Figure 1.

The form of the Clausius Clapeyron equation is somewhat cumbersome to use, especially in graphical form, and so an alternative equation was developed which used a log/log relationship to characterize the data.

Log Log Treatment of Vapor Pressure Data

$$\log Vp = A \cdot \log(T) + B$$

where: Vp is the vapor pressure,
T is the temperature (not absolute)
A & B are constants

Analyses of oxidized asphalts using this equation to establish the standard curve are presented in Figure 2. The agreement is also very good, with correlation coefficients for the individual asphalts greater than 0.999. Again all three

Table 2. Vapor Pressure Correlations for Asphalts

Class of Asphalt	For the Clausius Clapeyron Equation $\ln Vp (\text{mm Hg}^1) = a - b/T(^{\circ}\text{R}^2)$			Average correlation coefficient
	a	b	n	
Flux	18.2891	12725.60	10	-0.99976
Paving	20.7962	15032.54	8	-0.99985
Oxidized	18.8642	13458.56	13	-0.99991

Class of Asphalt	For a log log Equation $\log Vp (\text{mm Hg}) = A \cdot \log T (^{\circ}\text{F}^3) + B$			Average correlation coefficient
	a	b	n	
Flux	7.0850	-16.8999	10	0.99936
Paving	7.8871	-19.0600	8	0.99965
Oxidized	7.0607	-16.9570	13	0.99981

- 1 Pa = 0.0075 mm Hg
- 1 °K = (°R - 492) * 5/9 + 273
- 1 °C = (°F - 32) * 5/9

Table 3. Analysis of the Molecular Weight of Asphalt Tank Vapor Spaces

Asphalt	Weighted Ave MW	Milligrams of Component in Cube Sample of Vapor																						
		<C5*	n-C5*	5-6	n-C6	6-7	n-C7	7-8	n-C8	8-9	n-C9	9-10	n-C10	10-11	n-C11	11-12	n-C12	12-13	n-C13	13-14	n-C14	14-15	n-C15	>C15*
Coating - Plant J	83	3.70	2.10	1.80	2.10	0.82	1.70	1.70	0.82	0.21	0.26	0.23	0.05	0.02	0.04	0.01	0.02	0.04	0.01	0.01	0.15	0.07	0.14	0.13
Coating - Plant J	83	7.20	0.29	2.30	3.70	1.90	3.40	3.60	2.00	0.49	0.56	0.50	0.12	0.05	0.20	0.01	0.02	0.00	0.05	0.00	0.23	0.04	0.15	0.07
Satch - Plant J	91	3.00	1.90	2.10	2.90	1.70	3.00	3.70	1.80	0.66	0.73	0.67	0.17	0.11	0.03	0.01	0.01	0.01	0.03	0.01	0.04	0.02	0.05	0.05
Coating - Plant J	97	1.80	1.20	1.10	1.20	0.48	1.00	1.20	0.59	0.16	0.27	0.27	0.09	0.04	0.03	0.02	0.03	0.03	0.10	0.01	0.37	0.10	0.31	0.25
Flux - Plant P	76	2.00	0.70	0.40	0.49	0.34	0.39	0.48	0.15	0.10	0.05	0.03	0.01	0.00	0.01	0.00	0.02	0.00	0.01	0.02	0.02	0.00	0.09	0.14
Flux - Plant P	91	3.60	1.50	1.20	1.70	1.10	1.60	2.40	0.95	0.66	0.37	0.29	0.13	0.09	0.09	0.05	0.06	0.04	0.10	0.01	0.15	0.10	0.21	0.32
Steep - Plant P	93	3.00	3.00	1.50	2.40	1.00	2.00	1.80	0.84	0.41	2.00	1.80	0.07	0.02	0.02	0.01	0.05	0.00	0.01	0.03	0.00	0.00	0.08	0.38
PPBS* - Plant S	68	3.60	0.75	0.62	0.41	0.32	0.32	0.28	0.24	0.22	0.15	0.15	0.09	0.05	0.04	0.02	0.02	0.02	0.04	0.00	0.04	0.01	0.02	0.09
Steep - Plant P	85	3.70	5.40	2.70	5.10	1.60	2.30	1.10	0.41	0.12	0.06	0.04	0.01	0.02	0.00	0.01	0.01	0.00	0.10	0.00	0.14	0.00	0.13	1.00
Steep - Plant P	85	5.80	6.40	4.50	6.50	3.90	6.40	4.60	2.40	0.79	0.64	0.23	0.22	0.09	0.12	0.04	0.05	0.02	0.06	0.00	0.05	0.02	0.05	0.06
Steep - Plant P	72	3.20	1.70	0.79	1.30	0.40	0.81	0.49	0.27	0.10	0.09	0.04	0.02	0.04	0.01	0.00	0.01	0.00	0.05	0.00	0.10	0.02	0.08	0.03
PPBS* - Plant S	87	3.80	1.00	1.40	1.10	0.75	0.90	1.30	0.64	0.95	0.35	0.39	0.26	0.15	0.10	0.05	0.05	0.45	0.06	0.01	0.07	0.04	0.06	0.07
MW used for Fraction	30	72	79	86	93	100	107	114	121	128	135	142	149	156	163	170	177	184	191	198	205	212	240	
*Notes: used 30 (ethane) for MW of fraction less than pentane since when this is large it is heavily weighted to methane. used the average MW of the two bordering n-alkanes for the intermediate peaks. used 240 (C17 alkane) for MW of fraction > C15 since concentration decreasing as C15 approached PPBS refers to hard paving blend stock																								

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classes of asphalts show similar agreement.

Vapor Pressure Summary: Table 2 gives a summary of the regression constants to be used in either of the equations discussed above to calculate the vapor pressure for the three classes of asphalt at any temperature. Also indicated are the number of asphalts that were used to develop the equation for each class, and the average correlation coefficient characterizing the agreement of the data to the form of the equation for each individual asphalt in the class.

In AP-42 for tanks, the correct temperature to use in the Table 2 equations is the asphalt surface temperature in the tank. Since the surface temperature is rarely, if ever, known with certainty, the bulk temperature should be used to estimate emissions. In a well mixed tank the bulk temperature will be a good approximation of the surface temperature. Where mixing is not effective the surface will be lower in temperature than the bulk and the use of the bulk temperature will give a conservative estimate of emissions. In AP-42 for loading trucks, the bulk temperature of the tank from which material is being loaded provides a good estimate of the actual loading temperature.

Asphalt Vapor Molecular Weight: Asphalt vapor molecular weight was determined by separation and analysis of the organic species in the vapor spaces of 12 tanks storing different types of asphalt. These profiles were obtained by drawing known volumes of the tank vapor space through a charcoal tube, sealing and freezing the tube to limit loss of the sample, and then desorbing the organic material from the charcoal with carbon disulfide and analyzing with gas chromatography using packed columns and flame ionization detectors. Analyses were performed by CHEMIR Laboratory in St. Louis. Quantitative standards were used to identify the amount of individual normal alkanes from n-pentane to n-pentadecane. Peaks eluting between the normal alkanes were assumed to be isomers of the bordering alkanes, especially cyclic isomers of the lower carbon number alkane, and branched or unsaturated isomers of the higher carbon number alkane. The molecular weights for the n-alkane species and molecular weight estimates for the intermediate species were used with the amount of that material measured to calculate a weighted average vapor molecular weight for each tank, and then the twelve tanks were averaged together to get the molecular weight used for hot asphalt vapors in the AP-42 calculations. The result was a molecular weight of 84, which is used with all three classes of asphalts. This analysis is detailed in Table 3. Not enough data were available to assign different values to the three asphalt classes, however, from the table the unblown flux material in two tanks gave molecular weights which bracketed the average, as did the two paving blend stocks.

This analysis gave a lower molecular weight for the vapor space of asphalt tanks than for several petroleum solvents and fuel oils. This seems like a contradiction considering the nature of asphalt as the residuum material collected upon distillation. This contradiction is resolved by considering that asphalt is not a uniform material chemically and that the lower molecular weight materials

Table 4. PM/VOC Partition Data from Owens Corning Testing

Asphalt Plant O	Tank A	Tank B	Tank C	
VOC Test	0.73	1.16	0.98	lb/hr ¹
PM Test	0.21	0.38	0.30	lb/hr
VOC Fraction	0.78	0.75	0.77	

Roofing Plant S Coater Results:
Measured at different points. Data indicated 22% of total emission (VOC + PM) was PM and 78% was VOC

1. 1 kg/sec = 0.0076 * lb/hr

are preferentially evaporated. More importantly, it has also been established that thermal cracking of asphalt in hot storage tanks creates low molecular weight materials which accumulate in the tank vapor spaces [5,6].

Asphalt Liquid Molecular Weight: The actual bulk asphalt molecular weight is not needed for AP-42 calculations of emissions from tanks or loading racks, but is useful in some calculations that are beyond the scope of this paper, for example using Raoult's law for crude estimates of emissions from mixtures of asphalt and other materials. Molecular weight of bulk asphalt is not a well defined material property, both because asphalt is such a complex mixture and because intermolecular interactions in the asphalt create the appearance of high molecular weight in many measurement techniques. The measured molecular weight is usually not truly representative of the covalently bonded molecules. The difficulty in getting accurate asphalt molecular weight measurements is extensively discussed in the literature [8, 9, 10]. The use of Gel Permeation Chromatography [8], Field-Ionization Mass Spectrometry [8], Vapor Pressure Osmometry [8,9,10], and Freezing Point Depression [10] have all been evaluated as methods for measuring the molecular weight of asphalt or its components. The topic is further complicated for emission calculations by the fact that many of the measurements have been made on fractions of the asphalt and not on the neat asphalt. In general, for very rough estimates, a value of 1000 [8] can be used for the molecular weight of bulk asphalt. This value should be used with the understanding that there is much variation in the true molecular weight and in the tendency for intermolecular interaction due to petroleum crude source and processing conditions.

Partition of hydrocarbon emissions that are particulate and VOC: Because of its heterogeneous nature, asphalt fumes are varied and may have components that are classified as condensed particulates (PM) or as volatile organic compounds (VOCs). It was evident in analyzing asphalt fume results that the difference between these two classes of criteria pollutants is really defined by the method used to

test for the pollutants. Estimation schemes described in this paper calculate the sum of both (AP-42), or just the VOC component (non-AP-42 technique described below), and the partition needs to be understood to provide the best estimated values of the two pollutants. To that end, tests have been done on both asphalt tank exhausts in an Owens Corning asphalt plant and on the asphalt shingle coater exhausts in an Owens Corning roofing plant using EPA Methods 5 & 25A sampling protocols which define VOC and PM emissions in hydrocarbon fumes. Under conditions specified by the test method some fraction of the fume is captured on a filter and this is defined as a particulate emission, while a fraction of the hydrocarbon emission passes through the filter and this is defined as a VOC emission. The results of the split in the total hydrocarbon fume between VOC and particulate were approximately 78% VOC and 22% particulate in the asphalt equipment, in spite of the basic difference between a shingle coater and a storage tank. Data from these tests are given in Table 4.

NON AP-42 CALCULATIONS TECHNIQUES:

Estimation of VOC and particulate emissions from tanks with fume control: Many asphalt tanks have their fumes actively collected and treated in a control device, either a fiber bed filter or an incinerator. In these tanks it is common at Owens Corning to allow some air to pass through the tank vapor spaces to create an air sweep that controls combustible fumes well below the lower explosion limit (LEL) in order to prevent explosions. Because of the active removal of fumes in these systems, and the bleeding of air into the vapor space, the assumptions underlying the AP-42 tank calculations no longer apply. Specifically the driving force for the flow of fumes out of the tank is no longer just the working and breathing losses, and an alternative method of emission calculation is needed.

Several years ago safety concerns with asphalt tanks prompted Owens Corning to institute the periodic measurement of the combustible gas concentration in all asphalt tank vapor spaces [5]. With the advent of Title V it was recognized that these measurements could be used to estimate VOC emissions. As part of the safety program, techniques were developed to make this routine measurement simple and easy, and the result was the use of Mine Safety Appliance (MSA) combustion meters to quantify the hydrocarbon concentration in terms of the fraction (or %) of the LEL. This technique and the validation of its accuracy has been described in detail in a separate publication [6]. In addition to the combustible gas measurement, a slightly more complicated technique is also described and validated that gives the concentration of ethane, methane, and other light combustible gases separate from propane and larger hydrocarbons. This technique involves using a charcoal tube in the line between the tank and the MSA meter. The charcoal tube adsorbs all propane and higher hydrocarbons [6], with the resultant reading at the MSA meter due only to the lighter

Table 5. Fraction of Measured Combustible Gas that is not VOC or Particulate

	Asphalt Type	
	Oxidized	Unoxidized
Number tanks measured	109	47
Fraction combustible gas that is non-VOC/PM		
Average	0.52	0.23
Standard Deviation	0.12	0.23

materials. The charcoal tube technique was developed to troubleshoot excessive thermal cracking in asphalt tanks as a cause of high combustible gas levels in tank vapor spaces, and it is not routinely performed. It is important for emission calculations since the smaller combustibles found in the tank vapor spaces and measured with the charcoal tube in place (ethane, methane, hydrogen sulfide, and carbon monoxide) are not classified as VOCs because they do not react with ozone in the atmosphere. Nor are they particulate. The other hydrocarbons trapped by the tube, and only measured when the charcoal tube is not present, are VOCs or particulate. Table 5 gives the results of testing of vapor spaces of oxidized and unoxidized asphalts for

these two types of combustible gas measurements. This analysis was done to see if the routine combustible gas numbers should be adjusted for significant and predictable non-VOC/PM components. For the average tank storing oxidized asphalt, 52% of the combustible gas is non-VOC/PM and this value was used for this class of asphalt. For unoxidized asphalts, both paving and flux, the non-VOC/PM %LEL varied widely and was not nearly as large a fraction of the total. For these asphalts, all of the combustible gas measurement was considered to be either VOC or particulate.

Calculation of VOC & PM from combustible gas readings: Given this background the actual calculation of VOC emissions from combustion meter measurements is as follows:

1. Combustion meter measurements from tank vapor spaces read in %LEL are adjusted for the fraction of that reading that is non-VOC/PM. This value depends on the type of asphalt in the tank.
2. The adjusted %LEL is then turned into a weight per volume concentration. Hydrocarbons have a relatively constant actual LEL concentration, 45 mg/liter, when expressed on a weight per volume basis [11], and this constant is used to make this calculation.
3. The weight per volume concentration from step 2 is multiplied by the fume removal flow (in volume/time) in the tank to get the VOC emission (weight/time) going to

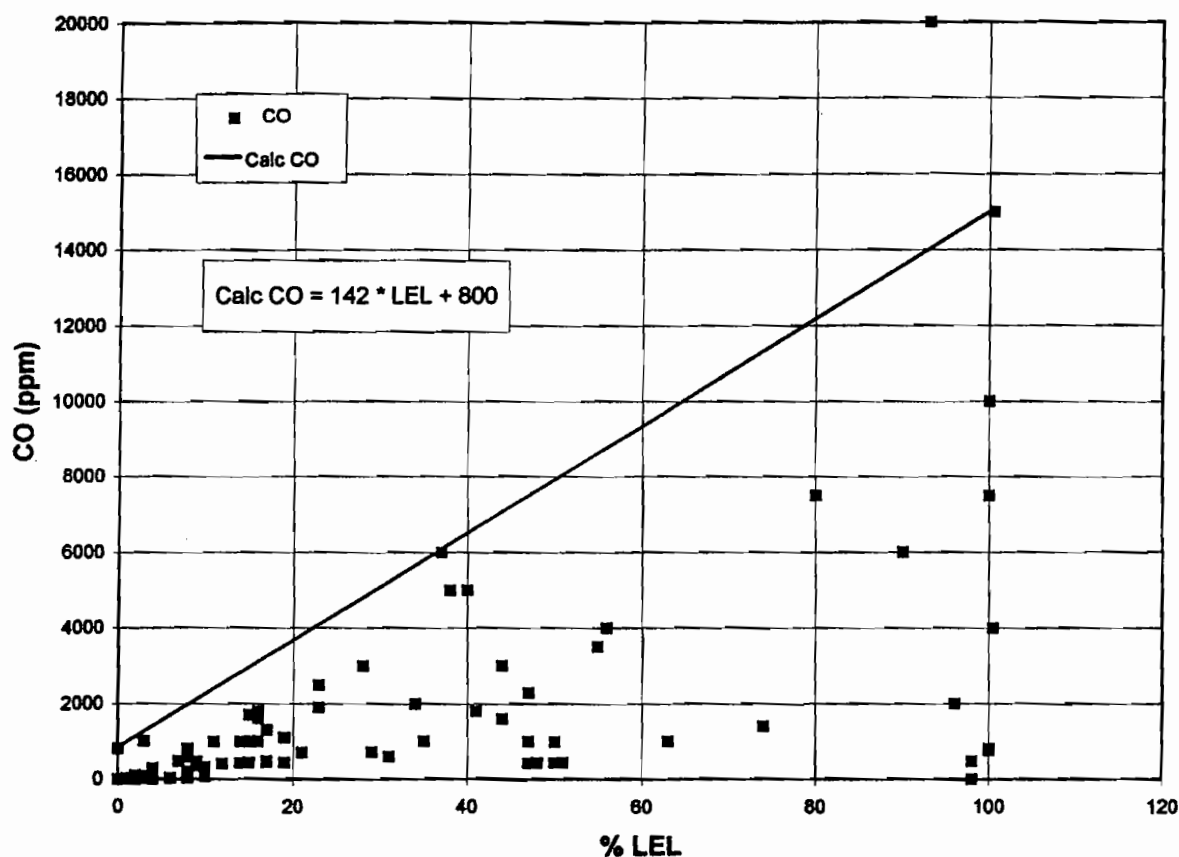


FIGURE 3. Relation of CO with % LEL Data for Oxidized Asphalts

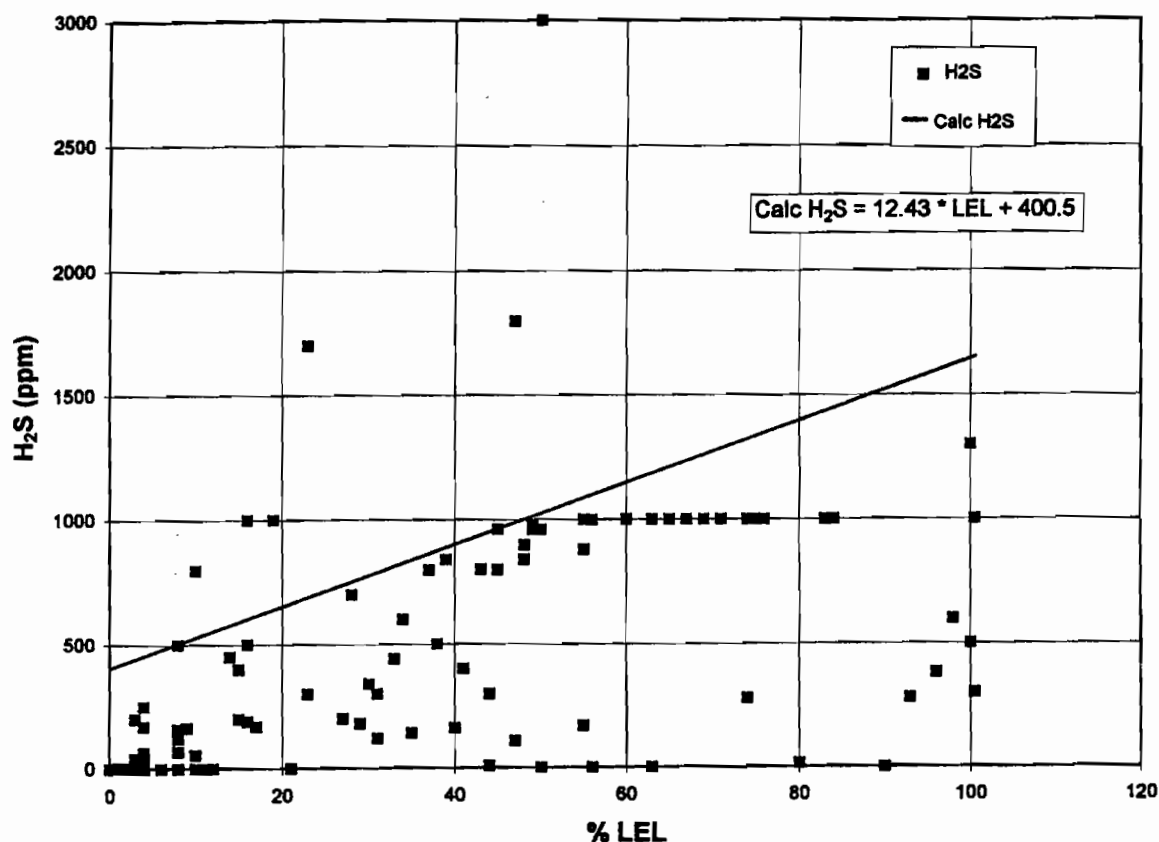


FIGURE 4. Relation of H₂S with % LEL Data for Oxidized Asphalts

a control device. It is consistent that the %LEL method measures VOC and not total hydrocarbon since the fume is drawn through a cotton filter prior to entering the combustion meter, and particulate will be filtered out.

4. The particulate emission going to the control device is estimated from the constant ratio of 22%PM/78%VOC outlined in Table 4.
5. The control device destruction efficiency is applied to both VOC and particulate emissions separately to get the final hydrocarbon based emissions from the tank. This is done after the calculation of PM emissions since the control efficiency for particulate and VOCs can be different depending on the control device.

This methodology's accuracy has been confirmed by tests in an Owens Corning asphalt plant on several

passively vented tanks while material was pumped into the tank and vapors forced out by the known pumping rate. Emissions calculated with the method outlined above were compared to tank emissions calculated using AP-42 (valid in theory in this case due to the lack of a ventilation system), and to emissions measured using EPA Method 25A. As can be seen in Table 6 the method based on actual combustion meter tests is similar to the measured VOCs, while AP-42 estimates are 3 to 5 times higher.

Estimation of CO and H₂S emissions from asphalt tanks: As part of the safety monitoring program mentioned above, Owens Corning has also used detector tubes in asphalt tanks to measure the vapor space concentration of carbon monoxide and hydrogen sulfide [6]. These emissions are usually ignored in asphalt tanks, however, the data Owens Corning has taken clearly indicates their presence in tank vapor spaces and therefore their emission [5]. These gases are not routinely measured in Owens Corning asphalt tanks, unlike combustible gas measurements, and thus fresh data are not available for current calculation, nor are data available for every one of our tanks. To apply these data to all tanks, a surrogate measurement is necessary. Since the same mechanism, thermal cracking, that produces light hydrocarbons in asphalt tank vapor spaces also produces carbon monoxide and hydrogen sulfide, the periodic combustion meter measurement of tank vapor spaces was

Table 6. Owens Corning Tank Fume Sampling Results - VOC Emissions

	Tank A	Tank B	Tank C	
VOC Method 25A Test	0.73	1.16	0.98	lb/hr ¹
% LEL Based Estimate	0.72	0.91	0.83	lb/hr
AP-42 Based Estimate	3.17	4.5	3.39	lb/hr

1. 1 kg/sec = 0.0076 * lb/hr

**Table 7. Asphalt Plant O:
Tank Emissions of H₂S and CO**

	Tank A	Tank B	Tank C	
H₂S Data				
Actual Test	0.06	0.12	0.15	lb/hr ¹
% LEL based estimate	0.19	0.18	0.20	lb/hr
CO Data				
Actual Test	0.20	0.17	0.23	lb/hr
% LEL based estimate	0.74	0.85	0.83	lb/hr

1. 1 kg/sec = 0.0076 * lb/hr

investigated as a surrogate for CO and H₂S. Data for CO and H₂S are plotted in Figures 3 and 4. Because of the scatter of data in the correlations a representative line was chosen for each material that was more conservative than nearly all of the data, in other words a line that defined a maximum concentration of CO and H₂S that could be expected in an asphalt tank from the combustion meter measurement. The equations used in the calculation of CO and H₂S concentrations from combustion meter results follow.

$$\text{CO (ppm)} = 142 * \%LEL + 800 \text{ for oxidized asphalt}$$

$$\text{H}_2\text{S (ppm)} = 12.43 * \%LEL + 400.5 \text{ for oxidized asphalt}$$

In unoxidized asphalt no such correlation was seen and conservative values of 500 ppm are used for both species.

To estimate an emission from this correlation the CO and H₂S concentrations are multiplied by the flow out of the tank to get emissions, and conversion factors are used to transform this into a weight per time emission. Any control device destruction efficiency is then applied. The emissions using these techniques can be significant. Limited direct measurement in an Owens Corning asphalt plant was consistent with this approach, at least in so far as that the %LEL approach was conservative. H₂S was the closer of the two estimates. Data are presented in Table 7.

One consequence of fume incineration is that one mole of H₂S in the fumes is oxidized to one mole of SO₂. The amount of H₂S oxidized to SO₂ is the amount of H₂S generated minus both the amount that escapes at the source and the amount that is not incinerated at the control device, or in effect the total uncontrolled H₂S emissions minus the emissions remaining after control. Because of the reaction with oxygen and the molecular weight differences between H₂S and SO₂, every pound (2.2 kg) of H₂S emission is oxidized to 1.88 pounds (4.14 kg) of SO₂ emission.

Loading Rack emissions of CO and H₂S: As in the tanks, %LEL versus CO and H₂S correlations are used to estimate these components in loading rack emissions. Again, with incineration, the H₂S is oxidized to SO₂. Flow out of the tank truck during loading is needed for CO and H₂S calculations. When fumes are collected, that flow can be

either the more conservative flow induced by the fume fan, or the lower and more realistic displacement of air by the asphalt being loaded. When no collection takes place that flow is the displacement of air by asphalt being loaded. Combustion meter measurements of %LELs from the tanks used for loading are used for these calculations.

EFFECTIVENESS OF FIBER BED FILTERS FOR ASPHALT FUME EMISSION CONTROL

One device used extensively to control asphalt fumes is a fiber bed filter. Fumes are actively pulled through these filters or passively breathe through these filters. Their first use at Owens Corning was to control opacity to comply with NSPS regulations, and for this application they have proven to be quite effective.

Testing was done on both asphalt tanks and on a roofing line coater to determine the control efficiency of fiber bed filters for both VOC and particulate emissions. Data from the testing are summarized in Table 8. In all cases, the particulate collection in the filter exceeded 90% of the emissions in the input stream. This value agrees well with manufacturer's estimate of 95% and with the observation that these devices can eliminate opacity. However, VOC removal varied widely in the tests. With the average removal near zero, and a very large variation, it was decided that no removal of VOC by these filters could be assumed. Although organic oil is collected, this oil is considered part of the particulate fraction of the hydrocarbons in the fumes and not the VOC fraction. Indeed the lack of removal of VOCs by these filters is consistent with the method of partitioning hydrocarbons into VOC and particulate described above – namely VOCs pass through a testing filter and particulate do not. Based on the effectiveness of these control devices to eliminate opacity it is assumed that particulate greater than 10 micron is captured by the fiber bed filter so that the total particulate emissions from the fiber bed filter are considered to be PM10 emissions.

Fiber bed filters are not considered to be a control device for CO and H₂S in tank or loading rack fume streams.

**Table 8. Effectiveness of Fiber Bed Filters
for Emission Control from Asphalt Tanks**

Plant	Equipment	Pollutant	Control Efficiency
Asphalt O	Tank 1	VOC	-35.7%
Asphalt O	Tank 1	VOC	5.7%
Asphalt O	Tank 1	VOC	43.4%
Asphalt O	Tank 57	VOC	5.3%
Roofing I	Coater	VOC	0.0%
Asphalt O	Tank 1	Total Particulate	95.7%
Asphalt O	Tank 57	Total Particulate	90.7%
Asphalt O	Tank 1	Filterable Particulate	100.0%
Asphalt O	Tank 57	Filterable Particulate	100.0%

Table 9. Summary of Data for Calculating Asphalt Tank Emissions

Data Type	Flux Asphalt	Paving Asphalt	Oxidized Asphalt
Clausius Clapeyron constant a for vapor pressure ¹	18.2891	20.7962	18.8642
Clausius Clapeyron constant b for vapor pressure ¹	12725.6	15032.54	13458.56
Log Log constant A for vapor pressure ²	7.085	7.8871	7.0607
Log Log constant B for vapor pressure ²	-16.8999	-19.06	-16.957
Asphalt vapor molecular weight		use 84 for all types of asphalt	
Asphalt liquid molecular weight		very rough estimate – 1000	
Partition of hydrocarbon fumes into particulate and VOC		use 22% particulate, 78% VOC for all types	
% Fumes that are VOC or particulate, versus non VOC/PM	100%	100%	48%
Vapor space carbon monoxide (conservative estimate) ppm	500	500	142 * %LEL + 800
Vapor space hydrogen sulfide (conservative estimate) ppm	500	500	12.43 * % LEL + 400.5
Fiber bed filter control of VOC		use 0% for all asphalt types	
Fiber bed filter control of particulate		use 90% for all asphalt types	
1. ln Vp (mm Hg) = a + b/T (°R)			
2. log Vp (mm Hg) = A * log T (°F) + B			
1 Pa = 0.0075 mm Hg, 1 °K = (°R - 492) * 5/9 + 273			
1 °C = (°F - 32) * 5/9			

CONCLUSIONS

Estimation of air emissions for asphalt tanks and loading racks can be done using AP-42 calculation methods given appropriate data on asphalt properties. More precise estimates of emissions, or estimates for tanks using ventilation schemes that compromise the AP-42 assumptions, can be done using a simple measurement of the combustible gas in the vapor space. Methods to do this are outlined in the paper. Data that is useful with all these methods are summarized in Table 9. These data are given for three major classes of asphalt: paving, flux and oxidized.

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Appendix C

Appendix C

In the preamble to the proposed rule at page 58616, EPA states that the total roofing-industry capital cost of the rule is estimated to be \$2.16 million. The total annualized cost including the annualized capital cost and operations and maintenance (O&M) is \$758,000; and the monitoring, recordkeeping, and reporting costs total \$250,000. The total for all of these costs is \$1.01 million per year. ARMA believes that U.S. EPA underestimated some of these costs.

This appendix contains ARMA's analysis of the cost calculations developed in the September 11, 2001 memorandum from Mary Lalley of ERG to Rick Colyer of (hereinafter "the ERG report"), ERG has estimated that¹:

For the 10 facilities projected to be subject to this rule, it was assumed that 4 would comply by routing the exhaust from loading racks and storage vessels to an existing thermal oxidizer and require only the addition of ductwork. Four facilities were assumed to add a thermal oxidizer and ductwork. Two facilities are already controlling all blowing stills, tanks, and loading racks with a thermal oxidizer and will not require an additional thermal oxidizer or ductwork to control these emission sources.

Later on page 14, ERG reports that the total capital costs for the 10 facilities is estimated to be \$2,160,000. These costs were estimated using the EPA's OAQPS Control Cost Manual, 5th Edition and the associated Lotus 1-2-3TM spreadsheets called CO\$T-Air. EPA has also used CO\$T-Air to develop cost estimates for any new or reconstructed facilities that will be built after the regulations go into effect. ARMA's review of the information presented in ERG report raises the following concerns:

- The capital costs appear to be too low.
- There are numerical errors in some of the calculations.

Due to the lack of complete input data, it is not possible to replicate ERG's cost calculations using the CO\$T-Air spreadsheets. However, ARMA has independently estimated the cost of MACT controls for a new or reconstructed facility. ARMA's cost-estimate is for a new plant that has an asphalt throughput rate of 50,000 tons per year.

¹ Lalley, p. 14

ARMA's cost estimate is based on the following:

- The facility is a single line roofing operation. The line consists of a coater, a saturator, a wet looper, a sealant applicator, an adhesive applicator and all asphalt storage tanks.
- The plant and control system are designed for effective capture of emissions; fugitive emissions escaping the roof fans are minimal.
- The lines are controlled by a thermal oxidizer that operates at a VOC destruction efficiency of 95%.
- The control device is fitted with a temperature monitoring device and data averaging and data logging capability. The device is able to record temperature readings every 15 seconds and generate a moving 3-hour average every 15 seconds.
- As specified in EPA's CO\$T-Air spreadsheet for thermal incinerators, the life of the equipment is 10 years; the capital recovery factor is 7%.

The cost estimate for this control device and associated equipment is shown on Table 1 on the following page.

Table 1 – ARMA Cost Estimate for an RTO

CAPITAL COSTS

Capital Cost to Purchase Unit (CVM quote, RTO, 27,000 cfm) ²	\$775,000
Installation & Erection Cost ³ : (from Chester AR)	\$300,000
(assume greenfield installation)	
Design ventilation system adequate to meet Method 23 ³	\$20,000
Install Ventilation System (ducts, fans, hoods) ³ :	\$250,000
Engineering: (from Chester, AR) ³	\$50,000
Instrumentation	\$50,000
Capital Cost subtotal	\$1,445,000
<i>Sales tax: (@approx 7.5%)</i>	\$108,375
<i>Freight</i>	\$25,000
Performance Test	\$10,000
Contingencies (at 10%)	\$144,500
	\$1,732,875

ANNUALIZED CAPITAL COSTS

To Annualize \$1,732,875 over a 10 year life, 7% interest, CRF = 0.1424	\$246,761
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OPERATIONS AND MAINTENANCE COSTS

Labor cost	\$5,000
Annual Electric Cost (\$.10/KWH, per CVM quote)	\$150,000
Annual Gas Usage Costs (@5.00/MM BTU, per CVM quote)	\$104,000
(assume firm gas)	
Indirect Overhead (Assume 60% of Maintenance Costs)	\$3,000
Miscellaneous (annual maint. Parts, administration, insurance, etc.)	\$5,000
Total O&M Cost	\$267,000
 MRR (Additional recordkeeping)	 \$25,000

ANNUAL COSTS = \$538,800

² See pages 5 – 9 for a facsimile of the budget proposal.

³ These costs were estimated by engineers at an ARMA member company based on experience installing similar units.

In Table 3-3 of the Final Report titled *Economic Impact Analysis of the Proposed Asphalt Roofing and Processing NESHAP* dated July 2001⁴, EPA has estimated the cost for new facilities to comply with MACT. This table is based on Table 4 in the ERG Report. The ERG report does not describe the size of the new asphalt manufacturing facility or the volume of air treated. ARMA believes that the new facility is of a comparable size to the ARMA model facility. ERG's cost estimate and comparison summary data from ARMA's analysis are presented below.

Table 2 Comparative Cost Estimates for New Facilities

	EPA Estimate	Corrected EPA Estimate	ARMA Estimate
Emission Control Cost			
EPA Total Capital Cost (\$)	939,900	939,900	\$1,732,875
Total Annualized Emission Control Costs			
Annualized Capital Costs (\$)	109,342	\$133,842 ⁵	246,761
O & M Costs (\$)	398,482	398,482	267,000
MRR Costs	26,538	26,538	25,000
Total	400,230 ⁶	558,862	538,761

A comparison of ERG's cost estimate to ARMA's shows that ARMA's capital cost for a new facility substantially exceeds EPA's cost for a similar facility. Note that ARMA has included design costs, installation and erection costs, freight, etc., in its capital cost estimate. It is essential to include these costs in estimating the impact of the rule; they occur solely due to the MACT requirements.

Note that there are two errors in EPA's calculations. First (assuming a 10-year life and an interest rate of 7%), the capital cost is not annualized correctly. Second, in adding the annualized capital cost to the O&M costs, the sum is not correct. Both of these errors serve to inaccurately reduce the calculated total annual cost for new or reconstructed facilities. The error is almost \$159,000 on a total cost of \$559,000.

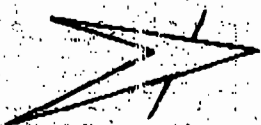
Conclusion

EPA has estimated the industry-wide annual costs at \$1.01 million per year for existing facilities. Based on the experience of ARMA members, this value appears to be significantly too low.

⁴ Final Report titled *Economic Impact Analysis of the Proposed Asphalt Roofing and Processing NESHAP* dated July 2001, EPA-452/R-01-010, p 3-2.

⁵ According to EPA's CO&T-Air spreadsheets, the interest rate should be 7%, the expected life of the equipment should be 10 years. Capital recovery factor = 0.1424, so Control Costs should be \$133,842

⁶ There is an error of unknown origin in EPA's calculation of the total cost. \$109,342 + 398,482 + 26,538 does not equal \$400,230.



CVM CORPORATION

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September 12, 2001

CVM Proposal No. 3983-24

Certain-Teed Corporation
499 Memorial Hwy. Ste. 135
Tampa FL 33634

Attn: Mr. H. R. Sanders

Re - RTO With Prefilter, KO Pot, Precooling

Dear Sir:

This is a budget proposal (equipment basis) for a thermal oxidizer that handles exhaust from an asphalt roofing plant. You have specified that VOC control is required. Thermal oxidation is a "must" to reduce the VOC content of treated exhaust. For this proposal, we selected a regenerative thermal oxidizer (RTO) because it is more fuel efficient than the alternative (which is a recuperative thermal oxidizer).

The design and performance data are presented in the attached Table. The comparison of capital and utility costs is presented in CVM File 3983-004.

John L. Wilki

Prepared by John L. Wilki

Enc: CVM Dwg. 3983-2, Brochure

JLV/smm

AIR POLLUTION CONTROL SPECIALISTS

September 11, 2001

Summary - Capital Cost

Thermal Oxidizer for Certain-Teed Corporation

Quote No. Oxidizer	Type Oxidizer	Prefilter Precooler	Equipment Price
> 3983-2	RTO	Yes	\$775,000.00
3983-3	TRO	Yes	\$737,000.00
3982-4	TRO	No	\$492,000.00

Summary - Utility Costs

Quote No. Oxidizer	Type Oxidizer	Prefilter Precooler	Fuel Gas @ \$4.00/MM	Power \$0.10/KWH
3983-2	RTO	Yes	\$104,000/yr	\$150,000/yr
3983-3	TRO	Yes	\$488,000/yr	\$120,000/yr
3982-4	TRO	No	\$468,000/yr	\$110,000/yr

Basis of Estimates

Operation	8,000 hr/yr
Fuel Gas Price	\$5.00/MM Btu
Power	\$0.10/KWH

All cases require a KO Pot

Cases 3983-2, 3 have an indexing prefilter (CVM design).

Cases 3982-2, 3 have a quench that uses limited water injection to precool exhaust available at 200°F to 130 - 150°F. (CVM design).

Please refer to specified Proposal for further information and clarification.

Encl: Proposal 3983-2, 3, 4. Ref. CVM Dwgs. 3983-2, 3.

Prepared by J. L. Wilki

John L. Wilki

September 11, 2001

- 2 -

Table 1

Design & Performance Specifications

CVM Proposal No.	3983-1
Thermal Oxidizer	Model 27-RTO-3
CVM Ref. Dwg.	3983-1
No. Stoneware Beds	Two (2)
Stoneware Bed Size Inside Dim.	9 ft ID x 8 ft H
No. poppet dampers required	Two (2)
Combustion Chamber Inside Dim.	10 ft ID x 16 ft W x 9 ft H
Construction	3/16" mild steel, 6/8" thick Pyrobloc
Nom. Heat Transfer Efficiency	95% HRE
VOC Destruction Efficiency	98% Destruct
Volume Design Basis	27,000 CFM @ 200°F
Volume, SCFM	21,700 SCFM @ 70°F
Est. Dil. Volume	120 SCFM H ₂ O
Blower Design Volume	21,820 SCFM @ 130°F
Blower Design Rating	NYB 504 DH - 250 BHP
Burner Peak Rating	4.5 MM Btu/hr
Burner Duty at nominal loading	2.6 MM Btu/hr
Temperature Ratings	
Exhaust at combined source	27,000 SCFM @ 200°F
Exhaust after partial quench	22,820 ACFM @ 130°F
Combustion chamber temperature	1500°F @ 0.75 sec Residence Time
Stack temperature	216°F
Overall Pressure Differential	37" WC
Approx. Plot Loading	250,000 lb

Thermal Incineration with Two-Bed Regenerative Heat Recovery

Thermal incineration is used to handle a variety of air pollution control problems relating to pollutants in process exhaust. This includes removing volatile organic components (VOCs), hydrocarbons, toxic chemicals, odors, and opacity from exhaust.

The energy required for incineration is derived from the preheat recovered in the regenerative heat recovery system, the heat of oxidation of VOCs and hydrocarbons, and fuel burned in the combustion zone burner. The advantage that regenerative heat recovery offers is that it can

be designed for up to 95% HRE (heat recovery efficiency)—thus minimizing fuel consumption.

The high cost of regenerative heat recovery has limited its usefulness. Our contribution toward making such systems more affordable is the development of fast-acting valves to permit rapid reversal of flow through the system. The advantage of using fast-acting valves is illustrated on the cover—only two stoneware beds are required. Systems with slow-acting valves require an extra stoneware bed.

